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ARTICLES

NOTES ON COLLECTING MOSQUITOES[1]

OSMOND P. BRELAND
The University of Texas

INTRODUCTION. During the past several years, the writer and his associates have made hundreds of collections of mosquitoes and some of the collecting trips have been of several days duration. Specific objectives have varied from time to time, but general objectives have been to collect the specimens and to get them back alive to the laboratory for rearing and study. The percentage of living specimens of all stages successfully transported has been consistently high. The purpose of this paper is to describe briefly the methods of collecting and the equipment that is used. Prime objectives have been to keep collecting equipment to a minimum and as simple as possible. The writer does not claim that the methods and equipment used are entirely original; they have been developed over a period of years with contributions from other collectors, students and technicians. Some of this material may seem elementary to experienced collectors, but it is hoped that even they will find certain points of some interest.

EQUIPMENT. A sedan has been used for transportation with reasonable success, but it has been found that a station wagon is more satisfactory. Perhaps because of better air circulation, the percentage of living specimens at the end of a trip has been higher with the latter type of vehicle. Larval and pupal collections have been emphasized, since experience indicates that many more of these stages than adults can be found routinely in a limited time. On the other hand, if adults or egg rafts are encountered, they are also collected. The following equipment is carried routinely for each of the stages noted; the use of the equipment will be noted more fully later.

Larvae: Collecting equipment for larvae include the usual white enamel dippers and pipettes, half gallon wide mouth fruit jars with two-piece lids for transporting living larvae, and boxes divided into sections each of which will accommodate one fruit jar. Each box, which has a handle on each end, has a capacity of six fruit jars. The jars fit snugly into the sections which are lined with cork. To facilitate keeping accurate field notes, the jars and sections are numbered with black paint, each jar being carried in the section with its corresponding number. The central portion of the two-piece lids of the jars has been replaced with fine copper wire which allows air to enter.

In view of the possibility that all the larvae in some of the collections will die or pupate before they reach the laboratory, small screw top vials with bakelite lids are used for preserving a portion of those collected. The preservative used is 95% alcohol, but when this is added to the larvae, sufficient water remains to dilute it somewhat. Absorbent cotton is used to pack the preserved larvae.

At least one white enamel pan which will hold the contents of a half gallon jar is carried so that the larvae may be examined more closely at the end of the day.

Pupae: On a trip of several days duration, it is not at all unusual for many larvae to pupate in the collecting jars, and frequently, many pupae are collected at the same time as are larvae. The pupae may of course be quite different from the larvae, and adults which emerge in the

[1] The methods and equipment described herein were developed while working on projects supported by a research grant, E-507, from The Microbiological Institute of the National Institutes of Health, Public Health Service; and by grants from The University of Texas Research Institute.

collecting jars often fall into the water and are ruined. Consequently, one or more bell jars with top and side openings are carried to allow for possible adult emergence during the night. In addition, large shell vials four inches in length and 1¼ inches in diameter with cotton plugs and filter paper or cotton in the bottom are used for the transportation of living pupae. These vials are carried in a wooden block approximately 3½ x 3½ x 12 inches into which holes have been bored for the individual vials. Vials and holes are given corresponding numbers.

Adults: Sometimes vials of the same type as those described for pupae are used for transporting living adults. The smaller vials used for egg rafts, to be mentioned shortly, are also quite satisfactory. Small cyanide tubes and jars are used for killing adults. An aspirator and insect net are also useful on occasion for collecting adults.

Egg Rafts: A small metal instrument with one flattened end and sometimes called a section lifter, is used for collecting egg rafts. Egg rafts are transported in vials approximately 3 inches long and ⅞ inch in diameter. The vials are plugged with cotton, and several layers of filter paper are placed at the bottom of each vial. Vials are numbered and carried in a bored wooden block similar to the one used for the pupal vials.

METHODS. *Larvae and Pupae:* Larvae and pupae are transferred from dippers to collecting jars until it is felt that a reasonable sample of the instars and species present has been obtained. Only small quantities of water are allowed in each jar and when the collection is complete, the larvae of all collectors may be combined into one or more jars. Larvae and pupae are transported with the water level approximately two inches from the top of the jars, and if necessary, water is added until this level is attained. Appropriate field notes are made, but at this time larvae and pupae are not separated, nor are any larvae preserved.

At the end of the day the collections receive further attention. Each jar is emptied into the large enamel pan previously mentioned and the larvae are examined. Representative larvae from each collection are preserved by placing them in vials, removing most of the water and adding 95% alcohol. An appropriate label is placed in each vial and the specimens held in place by a small wad of cotton that is pushed into the vial until it comes in contact with the larvae.

If large numbers of pupae are present, some of them are put in small dishes and placed under bell jars. Often a surprisingly large number of adults will emerge during the night. The next morning the emerged adults are knocked out with ether and then transferred to cyanide jars. At a later date the adults are often put into screw top vials and held in place with a bit of cellucotton or tissue paper.

If there are pupae from more localities than there are bell jars, the extra pupae are placed in the pupal vials noted above. The pupae are added to the surface of the cotton or filter paper, and the excess water removed. Pupae will survive for many hours on the moist surfaces and will often emerge as adults while in the vials.

The living larvae which remain in the enamel pan are returned to the original jar for transportation to the laboratory. We have found larval mortality to be quite low although they have sometimes remained in the jars for as much as 72 hours and have been transported for more than 500 miles.

Adults: As we have implied previously, collections of adults have been somewhat subordinated to larval collections. However, adults are often attracted to our bodies, and they are sometimes seen near larval collecting sites. If our only interest is to obtain specimens, biting adults are collected by placing a small cyanide tube over them. If we want the specimen alive, we use a pupal or egg raft vial, and allow the mosquito to finish its meal before capturing it. This practice is of course not recommended in areas where mosquito borne diseases are prevalent.

Adults from vegetation or elsewhere in the vicinity are captured with an insect net or aspirator.

So far we have not attempted to carry adults great distances, but have done so successfully for more than 50 miles with no provision for moisture. On several occasions these females have deposited viable eggs in the laboratory. It is thought probable that moistened cotton or filter paper in the vial would increase the percentage of survival for greater distances.

Egg Rafts: A small amount of free water is added to the vials used for egg rafts. Each raft is lifted from the surface of the collecting site with a section lifter. Effort is made to have the raft near the end, since it is removed from the section lifter by sticking the end into the free water in the vial. After the raft has floated free, the excess water is removed from the vial with a pipette. This allows the raft to rest on the surface of the moist filter paper.

By using these methods we have had egg rafts retain their viability for several days although sometimes they partially hatch while in the vials. In the laboratory the vials are partly filled with pond water. This usually floats the rafts off the filter paper and frees any larvae that may have hatched. The egg rafts and any larvae which may be present are then placed in larger containers for hatching and rearing.

Summary: Methods and equipment used for collecting and transporting living mosquitoes have been described. Larvae, pupae, and egg rafts have been kept alive for 72 hours and transported over 500 miles; pupae often emerge successfully as adults in the vials used for their transportation. No effort has been made to carry adults this far or for this length of time, but they have remained alive for shorter times and distances.

A REPORT ON TESTS OF THE PERFORMANCE OF ADULTICIDING MACHINES IN CALIFORNIA [1]

A. W. A. BROWN [2] AND THOMAS D. MULHERN [3]

INTRODUCTION. The fifty-three local agencies presently engaged in mosquito control in California emphasize the control of mosquitoes while in the aquatic stages, by elimination or reduction of the sources and by the application of larvicidal measures. However, adulticiding is, on occasion, a necessary supplement to the control of the preadult stages, and many of the agencies maintain adulticiding equipment on a standby basis, for use as need may arise. A survey by the Forms, Records and Statistics Committee of the California Mosquito Control Association showed that there are employed by 28 of the agencies within the state the following numbers of machines:

Venturi Exhaust Generators (on jeep exhausts)	23
California Exhaust Generators (on jeep exhausts)	21
California Fog Applicators	10
Holmes Insect-a-Fog Machines	10
Mist Blowers (various makes)	11
Husman Pneumatic Sprayers	1
TIFAs	20
Bes-Kil Aerosol Generators	8
Total	104

[1] The testing program, the results of which are reported herein, was conducted from July 1 to July 15, 1954, as a joint study of the California Mosquito Control Association, Inc., and the Bureau of Vector Control of the California State Department of Public Health.

[2] Head, Department of Zoology, University of Western Ontario, London, Canada.

[3] Associate Vector Control Specialist, Bureau of Vector Control, California State Department of Public Health.

Machines of this type were extensively used during the 1952 encephalitis outbreak in adulticiding populated areas where mosquitoes were present. In addition to their normal use for the reduction of mosquitoes which have invaded residential areas, they are frequently employed to adulticide irrigated pastures or other sources where the adult mosquitoes can be destroyed before leaving the breeding site.

The following machines, described elsewhere in this report, were assessed for physical and biological performance:

Alaska Aerosol Atomizer	(Fig. 1; Plate 2, "A" & "B")
Venturi Exhaust Generator	(Fig. 2)
California Exhaust Generator	(Fig. 3)
California Fog Generator	(Fig. 4)
Holmes Insect-a-Fog	(Fig. 5)
Small California Mist-Blower	(Fig. 6; Plate 2, "C")
Large California Mist Blower	(Fig. 7; Plate 2, "D")
TIFA	
Husman Pneumatic Sprayer	

The study was an exploratory one, and the results should therefore be considered as indicative rather than conclusive. Due to exigencies of the time available, the droplet size assessments were based on a single sample for each setting of the various machines, chosen from a set of three samples which had been adjudged as satisfactorily representing the performance under these conditions.

PHYSICAL PERFORMANCE. The various machines to be appraised were operated at the settings normally employed by the operators in the field. The emission rates were determined at the same time that the aerosol samples were taken. The airborne material was sampled at a point 6 feet distant from the point of emission by drawing it through cascade impactors (Plate 2, "F") at 17.5 litres per minute (Brown & Watson, 1953). The slides, coated with Drifilm 9927, were then examined microscopically and the droplets sized by ocular micrometer, assuming a lens/droplet ratio (spread factor) of 2. From the cumulative total volume in the various size-classes, the mass median diameters were determined graphically, and the frequency distribution of sizes was derived. Plate 1 presents comparison photographs of some of the microscope slides which were exposed in the cascade impactor. In each case, only the second of the series of four slides which were used in assessing the specific machine is presented here. The squares which appear in the background of the protographs measure 85 microns; hence, a droplet lens which would just fill a square would be 85 microns in diameter, and would represent a droplet half that diameter, or 42.5 microns.

Two formulations were used: (a) 5 per cent DDT in fuel oil, made up by the Fresno Agricultural Chemical Company ("Red-Top"), and (b) 5 per cent DDT in diesel oil, made up by diluting a 30% concentrate in xylene ("Red-Top") with 5 parts of the diesel oil used by the Merced County Mosquito Abatement District. The emission rates and mass median diameters are shown in Table 1, and the frequency distribution of droplet sizes in Figures 1 through 7.*

Laboratory work (by Latta *et al.*, and by Yeomans) has established that the optimum droplet size for killing adult *Aedes* mosquitoes is between 13 and 16 microns. It will be seen from Table 1 that only two of the machines approximated this condition, namely the Venturi exhaust generator with diesel oil and the Alaska aerosol atomizer with both kinds of oil. A high content of droplet sizes too low to impinge upon mosquitoes (i.e. smoke) was produced by the Insect-a-Fog with the lower emission of diesel oil, and

* For graphs of the physical performance of the Microsol Generator, the Bes-Kil Generator, the Husman Sprayer, the TIFA Machine, and the Dyna-Fog Generator, see Brown and Watson (1953).

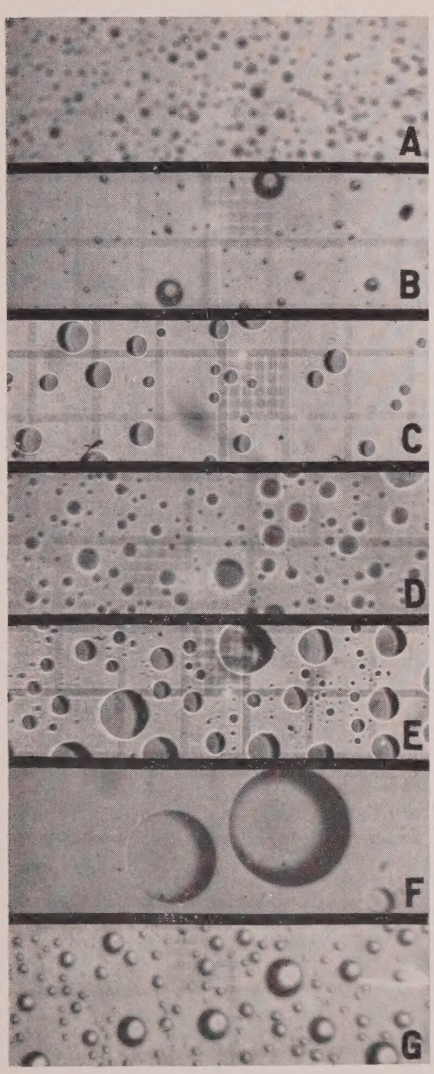


PLATE 1.—Photographs of portions of the fields of microscope slides exposed in Cascade Impactor.

"A"—Alaska Aerosol Atomizer. Light fuel oil—10 gph.

"B"—Venturi Exhaust Generator on Jeep. Light fuel oil—20 gph.

"C"—California Exhaust Generator on Jeep. Diesel oil—9 gph.

"D"—California Fog Generator. Diesel oil—60 gph.

"E"—California Fog Generator. Light fuel oil—60 gph.

"F"—Holmes Insect-a-Fog. Diesel oil—48 gph.

"G"—Large California Mist Blower. Diesel oil—38 gph.

by the California exhaust generator with fuel oil. A high content of droplets too large to remain airborne for a sufficient length of time (or distance) was shown by the California fog generator, the Venturi exhaust generator with fuel oil, the California exhaust generator with diesel oil, and the Insect-a-Fog at the higher emission rates. An attempt to modify the entire droplet spectrum in a downward direction was met, in those machines, simply by an increase in smoke at the expense of a decrease in large droplets.

The droplet sizes produced by the mist-blowers were significantly larger, especially with the smaller model, which has the higher emission rate. The droplet spectrum for diesel oil in the latter is that of a typical spray. However, fine mist droplets occur in all the mist-blower spectra.

It is stressed that the figures reported are based on single samples, picked as the best of 3 taken simultaneously. Difficulty was encountered with emission rates with the home-made machines, where valve settings could not be calibrated, and a small change in setting could mean a large change in emission rate. These machines also tended to be either "smokers" or "spitters," producing droplets that are either too large or too small, since the large droplets are wasteful and fall out after travelling a short distance, and the smoke-size droplets are carried into the upper air. As an example of the latter class, the California fog generator was tested by emitting a known volume of material over a large area of paper toweling spread in front of it. From the gain in weight of the toweling, it was found that with 30 g.p.h. emission the fallout was 0.1% in the first 5 yds. (principally from muzzle drip), 1.6% in the second 5 yds., and 1.3% in the third 5 yds., with very little beyond. With 60 g.p.h. the

TABLE 1.—Delivery rates of 5% solutions of DDT in oil (in U. S. gallons per hour) and mass median diameters (m.m.d.) of their droplet spectra (in microns)

	Formulation	g.p.h.	m.m.d.
Venturi Exhaust Generator	Fuel Oil	20	137
	Diesel Oil	18	16
California Exhaust Generator	Fuel Oil	12	4
	Diesel Oil	9	46
California Fog Generator	Fuel Oil	60	55
	Diesel Oil	10	43
	Diesel Oil	60	91
Holmes Insect-a-Fog	Fuel Oil	45	74
	Diesel Oil	35	3
	Diesel Oil	48	50
Alaska Aerosol Atomizer	Fuel Oil	10	5
	Diesel Oil	15	30
Small California Mist Blower	Fuel Oil	48	191
	Diesel Oil	48	231
Large California Mist Blower	Fuel Oil	33	70
	Diesel Oil	38	128

fallout appeared visually to be 4 times as great.

Samples of the airborne cloud were obtained on 9-inch squares (Plate 2, "E") of 25-mesh copper screening exposed at 100 yds., 200 yds., 300 yds., and 400 yds. distance from the machines. In these tests, the cloud was created by emitting 1 gal. of 5% DDT in diesel oil per 200 yards of frontage. The samples were placed in individual large test tubes, and sent to the Food and Drug Laboratory of the State Department of Public Health at Berkeley for assessment of DDT by the Schechter-Haller method. One untreated screen was sent with each group as a check. The machines tested were the California fog generator, the Holmes Insect-a-Fog, and the Large California mist-blower. Results of the assessments are shown in Table 2.

BIOLOGICAL PERFORMANCE. Comparisons were made between pairs of machines, based on their reduction of landing rates at distances up to 400 yards. In all cases, 1 gallon of 5% DDT in diesel oil was emitted along a 200-yard line at right angles to the wind. Landing rates were assessed by counting the number of landings on a 36-inch square of red broadcloth during 3 minutes (or 1 min., in high populations). Four or five observers were used, and counts were taken every 100 yards downwind. Pre-assessments were made immediately before treatment, and post-assessments were commenced 0.5 hour after treatment. Results were expressed as the reduction at post-assessment in percent of the pre-assessment count. They are presented in Table 3.

The dosage employed, equivalent to 0.18 lb. DDT per 100 yards frontage, was chosen as a sublethal one to give partial reduction in order to compare machines; this is about two-fifths the level of 0.47 lb. per 100 yards which Dickinson, Merritt and Hough had found in 1947 to give complete mortality of *A. nigromaculis* for 440 yards downwind. The dosage of 0.18 lb. per 100 yards did give the desired level of mortality in the flat fields at Merced, but not in a highly leveed field at Planada; this latter field was very heavily infested despite repeated airspraying, and it is therefore probable that a degree of DDT resistance was present.

The results in Table 3 show that machines with suitable droplet spectra, i.e., the Venturi exhaust generator and the TIFA,* are superior in performance

* The assumed superiority of the TIFA, which was not clearly evidenced in these experiments due to a defect in the machine tested, is based upon a thorough investigation by Brown and Watson (1953).

TABLE 2.—Aerosol samples taken on 9" squares of 25-mesh copper screen. Analyzed for DDT by Schechter-Haller method. Wind speed 4 m.p.h.

			DDT (milligrams) Recovered from Screens			
Date	Machine	g.p.h.	Untreated Screen	100 Yds.	200 Yds.	300 Yds.	400 Yds.
7/12/54	California Fog Generator	50	0	0.46	0	0	0
7/15/54	Holmes Insect-a-Fog	35	0	0.35	0	0	0
7/19/54	Large California Mist-Blower	38	0	0.35	0	0	0

TABLE 3.—Reductions of *Aedes nigromaculis* obtained with 1 gal. per 200 yds. frontage using 5% DDT in diesel oil, equivalent to 0.18 lb. per 100 yd.

Machine	Vehicle m.p.h.	Wind m.p.h.	Time hrs.	Percentage Reduction in Landing Rate 100 yd.	200 yd.	300 yd.	400 yd.	Average
Flat Fields at Merced								
Venturi Exhaust Generator	5.0 *	4	0645	57	91	94	0	60
California Exhaust Gen.	6.0 *	4	0600	0	87	80	6	43
Husman Pneumatic Sprayer	2.3	5	2030	70	90	69	70	75
Small Calif. Mist Blower	5.4	5	2030	96	90	58	58	75
Leveed Fields at Planada								
Holmes Insect-a-Fog	4.0	4	0630	52	18	41	0	28
TIFA	2.3	4	0615	39	56	0	7	31 †
California Fog. Gen.	3.2	4	2000	0	27	13	14	14
Large Calif. Mist Blower	4.2	4	1930	50	12	4	0	17

* 3.5 and 7 traverses made respectively.
† Burner too hot, with probable destruction of DDT.

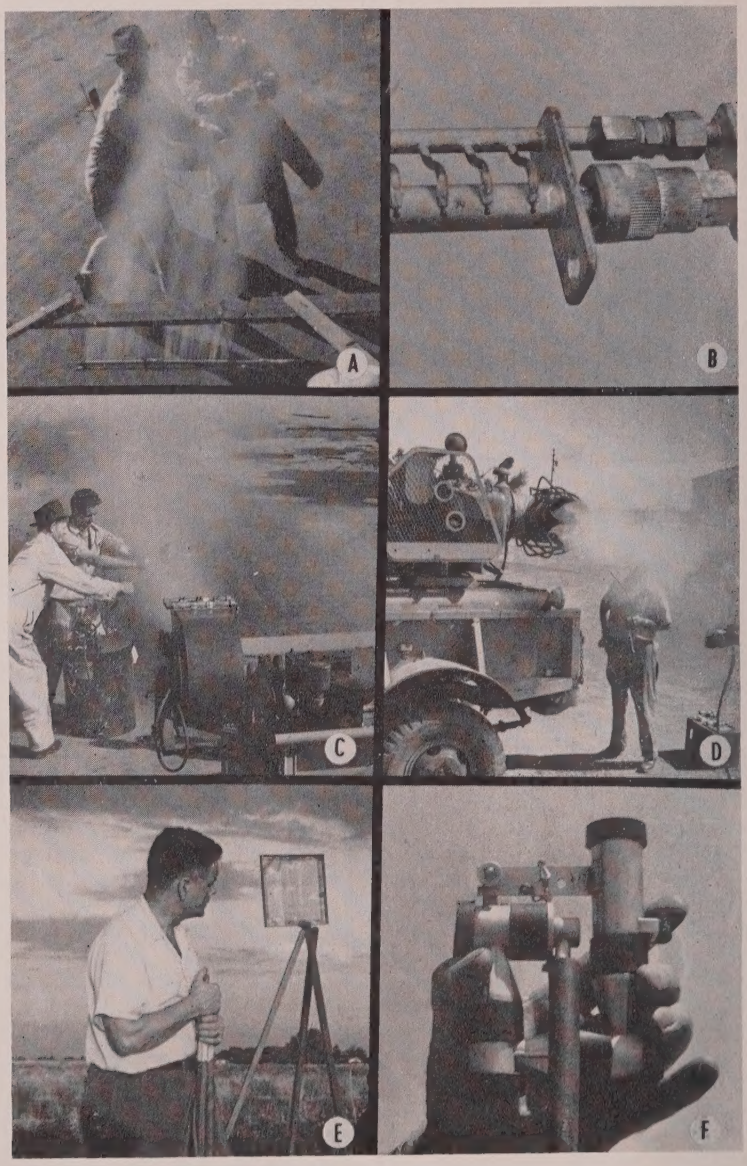
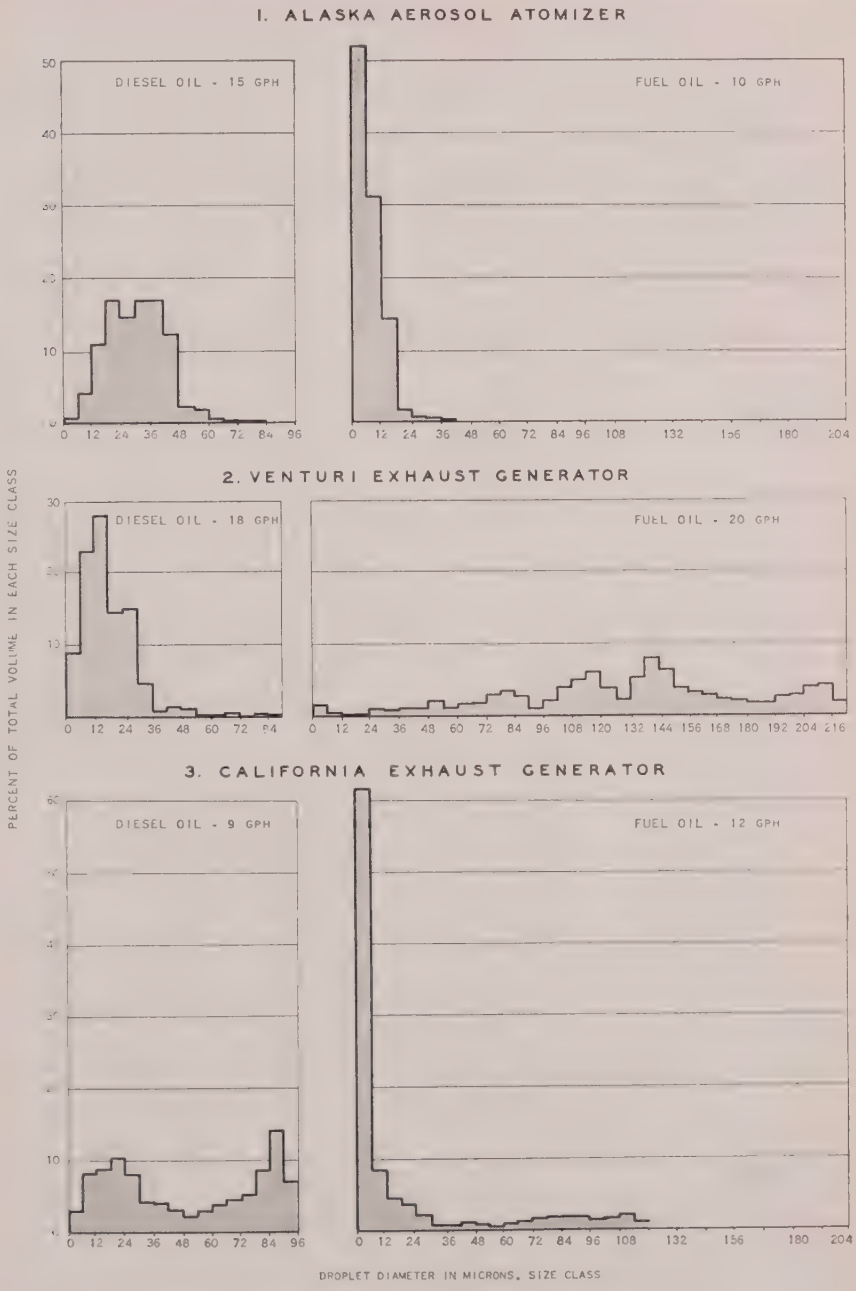
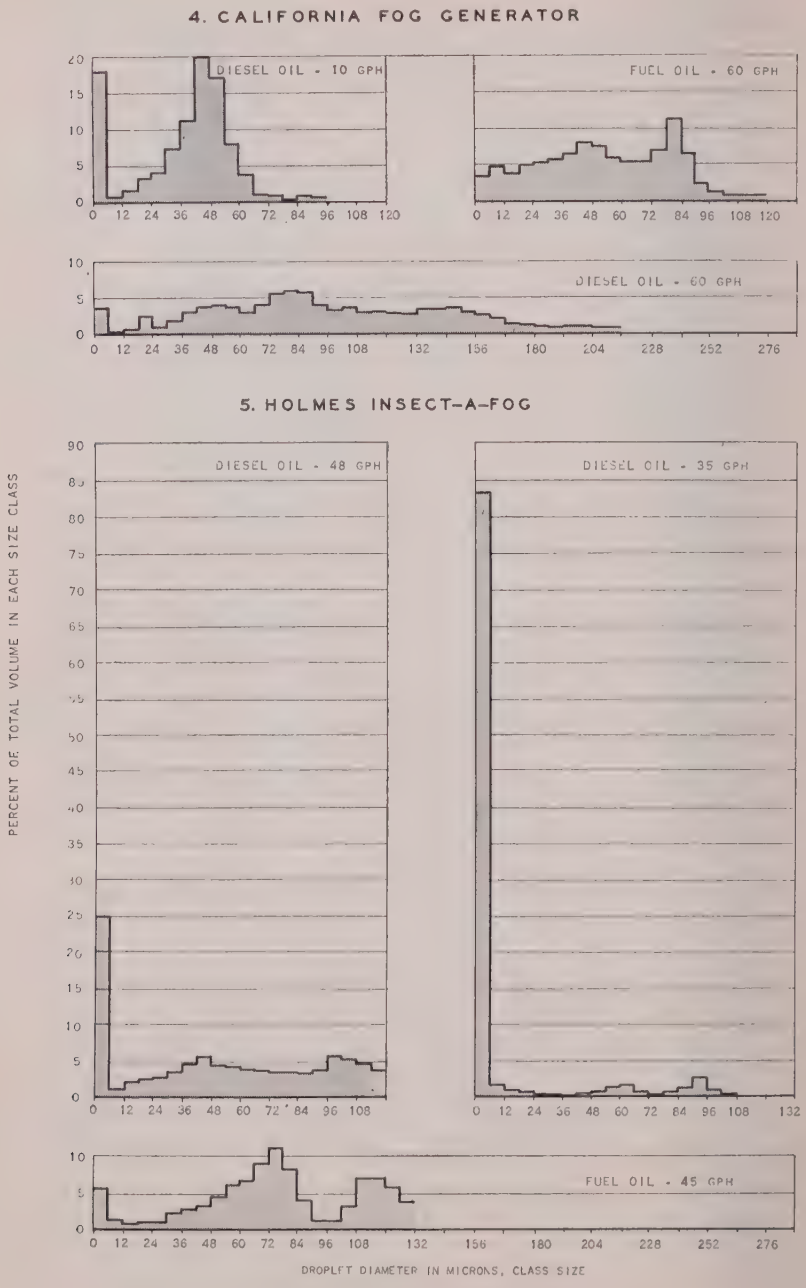


PLATE 2

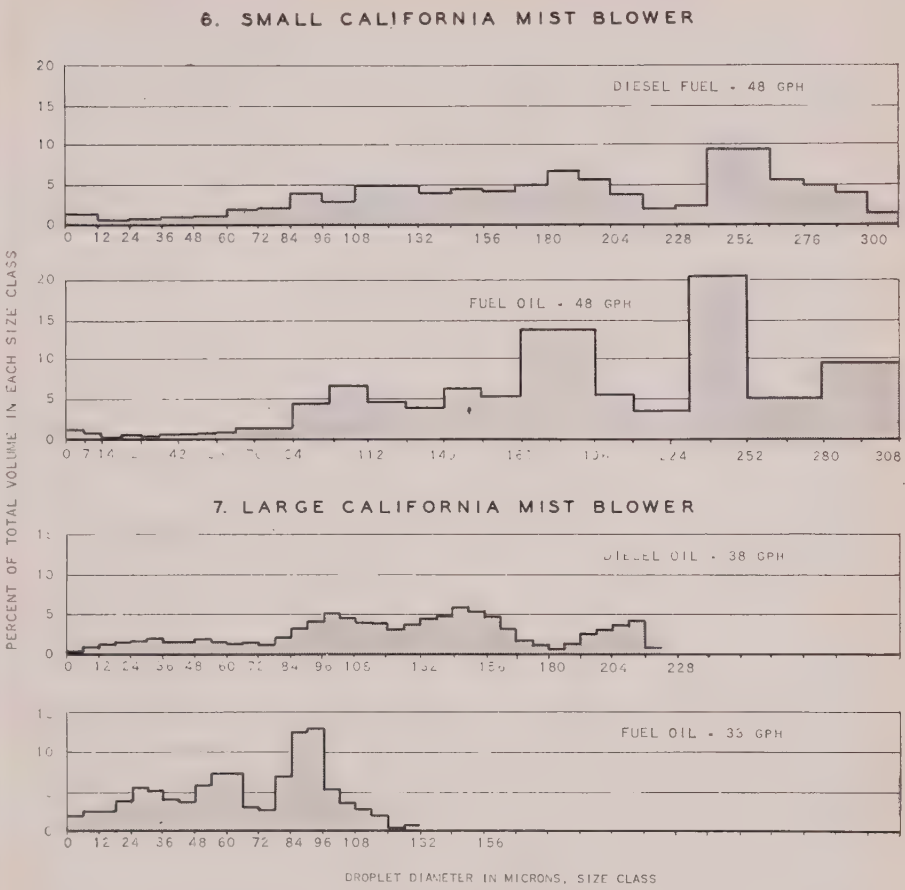
"A"—Sampling fog from two sections of Alaska Aerosol Atomizer.
"B"—Close-up of atomizing tips of Alaska Aerosol Atomizer.
"C"—Sampling fog from the Small California Mist Blower.
"D"—The Large California Mist Blower.
"E"—Nine inch square of 24-mesh copper screen used to collect a sample of the air-borne DDT insecticide, for quantitative analysis by the Schechter-Haller method.
"F"—Cascade Impactor used to cause droplets to impinge on microscope slides.


1. ALASKA AEROSOL ATOMIZER
DIESEL OIL - 15 GPH
FUEL OIL - 10 GPH
2. VENTURI EXHAUST GENERATOR
DIESEL OIL - 18 GPH
FUEL OIL - 20 GPH
3. CALIFORNIA EXHAUST GENERATOR
DIESEL OIL - 9 GPH
FUEL OIL - 12 GPH
PERCENT OF TOTAL VOLUME IN EACH SIZE CLASS
DROPLET DIAMETER IN MICRONS, SIZE CLASS

FIGS. 1, 2 and 3.—Droplet spectra from different machines, as noted.


4. CALIFORNIA FOG GENERATOR
DIESEL OIL - 10 GPH
FUEL OIL - 60 GPH
DIESEL OIL - 60 GPH
5. HOLMES INSECT-A-FOG
DIESEL OIL - 48 GPH
DIESEL OIL - 35 GPH
FUEL OIL - 45 GPH
PERCENT OF TOTAL VOLUME IN EACH SIZE CLASS
DROPLET DIAMETER IN MICRONS, CLASS SIZE

FIGS. 4 and 5.—Droplet spectra from different machines as noted.


6. SMALL CALIFORNIA MIST BLOWER
DIESEL FUEL - 48 GPH
FUEL OIL - 48 GPH
7. LARGE CALIFORNIA MIST BLOWER
FUEL OIL - 38 GPH
FUEL OIL - 35 GPH
PERCENT OF TOTAL VOLUME IN EACH SIZE CLASS
DROPLET DIAMETER IN MICRONS, SIZE CLASS

Figs. 6 and 7. Droplet spectra from different machines as noted.

to those with unsuitable spectra, i.e., the California exhaust generator, the California fog generator, and the Insect-a-Fog. The fog from the latter three machines had its greatest optical density at the top of the cloud which remained visible for many minutes and several miles, as it gradually gained altitude at the rate of about 40 ft. per mile. The lower part of the visible portion of these clouds did not descend to the ground for at least 100 yards downwind, and it is noteworthy that with both the California exhaust and the California fog generators no reduction was obtained in the first 100 yards downwind. The fog from the TIFA and Venturi exhaust generators hugged the ground and became invisible after traveling 0.25 mile; it was a characteristic of both machines that the vegetation immediately in front of the muzzle appeared to "reek" as the droplets entered the vegetation and gradually left it again some time after the main cloud had passed.

The reduction obtained with the mist-blowers was high in the Merced field and low in the Planada field. Naturally the greater reduction is obtained at 100 yards;

in the last 200 yards the landing rate is reduced by half, since the spectra contain a certain proportion of fine aerosol droplets, but there is no reduction where the mosquitoes are presumably resistant.

OBSERVATIONS AND CONCLUSIONS. 1. The California exhaust generator, the California fog generator and the Holmes Insect-a-Fog produce droplet spectra which are less satisfactory than those produced by the Venturi exhaust generator, the Alaska aerosol atomizer, the TIFA, and the Husman pneumatic sprayer.

2. Wind conditions in the San Joaquin Valley are very suitable for applying aerosols, since the wind is almost constantly from the northwest, with a typical speed of 4 to 5 m.p.h. in the early morning and evening.

3. Convection conditions in the San Joaquin Valley are very unsuitable for applying aerosols, since a high lapse rate obtains throughout the day; it disappears only 30 minutes before sunset and reappears 30 minutes after sunrise.

4. Biological conditions in irrigated fields of the San Joaquin Valley appear unsuitable for aerosols. *Aedes nigromaculis* was observed to harbor in the grass and rice; true aerosols, and certainly smoke, would pass over this harborage, particularly when protected by levees.

5. At sublethal dosages of 0.18 lb. DDT per 100 yd. frontage, aerosols obtain an average of 50 per cent reduction of *A. nigromaculis* for 400 yards distance downwind of the generator. In a population of this species which was presumed to be resistant, a reduction of only 25 per cent was obtained.

6. For the above reasons, mist-blowers traversing at 200 yd. crosswind intervals, and discharging droplets into the herbage at a distance, would probably give better results than aerosol generators at 400 yd. intervals. On leveed fields it would appear that air-spray is the only sure method of reaching the target.

ACKNOWLEDGMENTS. This work was accomplished with the able and arduous cooperation of J. R. Holten, of the Bureau of Vector Control, J. L. Mallars, of the Contra Costa County Mosquito Abatement District, L. E. Myers, Jr., and J. O. Stivers, of the Merced County Mosquito Abatement District, and other personnel of the Merced and other Mosquito Abatement Districts. The authors are indebted to the Entomology Division, Science Service, Canada Department of Agriculture, through C. R. Twinn, Head, Veterinary and Medical Entomology Unit, Ottawa, Canada, for making possible the participation of the senior author in this work.

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APPENDIX

Descriptions of machines assessed for physical and biological performance.

Venturi Exhaust Generator: An attachment 20 inches long and 1.2″ diameter affixed to the exhaust of a Jeep travelling at 6 m.p.h. in low gear, low range with the engine operated at 2,000 r.p.m. The Venturi throat is 0.5 inches in diameter. Delivery is gravity-fed through a ¼″ pipe (.364″ I.D.) ending at the throat, controlled by a ¼″ gate valve. The delivery rate employed, sufficient to give an 0.1″ creep-back at the muzzle, is 18 g.p.h. with diesel oil. This unit has been described as the Jeep Exhaust Venturi Aerosol Generator by Jones and Holten (1949).

California Exhaust Generator: An attachment 25 inches long, consisting of a generating chamber of 1¼″ pipe (1.38″ I.D.), a constriction of ¼″ pipe (.364″ I.D.), and an expansion chamber of

standard 2″ pipe (2.067″ I.D.) is affixed to the Jeep as above. The insecticide is emitted from a ⅛″ pipe (.269 I.D.) opening at the constriction, and is controlled as above. The delivery rate, sufficient to allow a drip of 1 drop per second from the muzzle, is 9 g.p.h. with diesel oil. This generator has been described, as the California Ground Thermal Aerosol Generator, by Raley (1947).

California Fog Generator: An assembly weighing 200 lbs. carried on a truck, consisting of a 3½ h.p. gasoline engine, an air blower, a combustion chamber, and 2 thermal fog units. Each fog unit is 30 inches long, and consists of a generating chamber 2.067 inches in diameter, a constriction 1.38 inches in diameter, and an expansion chamber 2.067 inches in diameter; the insecticide is pumped through a .269 inch tube into the constriction. Both fog units arise from a combustion chamber in which gasoline is burned and into which it is pumped at 70 p.s.i. The blast of air to be heated is supplied from a 20 c.f.m. blower and attains a temperature of 1000° F. in the fog head. The emission rate with diesel oil, adjusted to a drip at the muzzle of 1 drop per second, is 30 g.p.h. This generator has been described as the Plumber's Nightmare King Size, by Raley (1952).

Holmes Insect-a-Fog: This thermal generator consists of a 7½ h.p. gasoline engine, 350 c.f.m. blower, a combustion chamber, and a special thermal fog head; it weighs 675 lbs. The fuel is propane gas, supplied at 20 p.s.i., which heats the air to 1000 degrees F. The insecticide is pumped at 7 p.s.i. into the fog-head, and the fog then passes through an expansion chamber before being emitted in a fixed horizontal direction. The emission rate with diesel oil with the metering valve a half-turn opened, as employed in anti-mosquito fogging, is 35 g.p.h. The machine is made by Liquified Gas Engineering, 2932 North Wilson Way, Stockton, California.

Alaska Aerosol Atomizer: Attachments consisting of 12-inch sections each containing 16 atomizing points. At each of these points a 2.7 mm. tip emits the insecticide opposite a 5.4 mm. air orifice. The insecticide is aspirated along a 0.375 inch supply pipe, off which the tips are tapped; the air is brought in through a 0.5 inch supply pipe, in which the orifices are bored. When two sections are supplied with air at 40 p.s.i. from a 33 c.f.m. compressor (1 c.f.m. per tip), diesel oil is emitted at 6 g.p.h.; thus 15 g.p.h. could be obtained with the 5 sections employed. The atomizer was supplied for testing by Mr. Charles Wilson, Public Health Research Center, Anchorage, Alaska. This device has not previously been described in "Mosquito News"; therefore, photographs are included.

Small California Mist-Blower: This unit consists of an 8 h.p. gasoline engine, an air-blower, a 17 c.f.m. compressor, and a set of nozzles. The insecticide is pushed at 15 p.s.i., and air at 20 p.s.i. atomizes it, at 6 air-mix nozzles (Spraying Systems 40100 fluid, 120–6–35–60 air). These nozzles are arranged in two opposed banks of 3 each along the long side of the 8 by 10 inch blower case. The case is elevated at an angle of 45 degrees with the horizontal, and the air-stream issues at 50 m.p.h. with the engine at 2400 r.p.m. This machine was made by the Merced County Mosquito Abatement District to be bolted on a truck, and emits diesel oil at 48 g.p.h. See photo herewith.

Large California Mist-Blower: The unit consists of a 13 h.p. gasoline motor, an air-blower, a 33 c.f.m. compressor, and a set of nozzles. The insecticide is pushed at 40 p.s.i., and air at 50 p.s.i. atomizes it, at 6 air-mix nozzles (as above) arranged regularly around the 14 inch muzzle of a circular blower pipe, baffled internally and adjustable to any angle from the vertical. The air blast issues at 80 m.p.h. This machine, mounted on a truck, has been adapted by the Merced County Mosquito Abatement District from a commercially made mist blower. See photo herewith.

In addition to these 7 machines, not previously tested by these methods, the fol-

lowing 2 machines were used. They had been previously tested by Brown and Watson (1953).

TIFA: The Todd Insecticidal Fog Generator was operated with the insecticide pressure at 25 p.s.i., the fuel pressure at 60 p.s.i., and the particle size selector at 11; the emission rate with diesel oil was 20 g.p.h.

Husman Pneumatic Sprayer: This machine is described in detail by Husman (1953). It was run with the insecticide at 17 p.s.i. and atomized at 25 p.s.i.: the emission rate with diesel oil was 20 g.p.h.

SOME NOTES ON THE BEHAVIOR OF FOURTH INSTAR *ANOPHELES QUADRIMACULATUS* SAY (DIPTERA, CULICIDAE)

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Information on the behavior and activities of normal insects is necessary for properly evaluating their responses to many physiological and toxicological stimuli, yet, so far as the writer is aware, no one has given a complete qualitative descriptive list of the larval activities for even a single species of the Culicidae. Hocking's paper (1953) on *Aedes communis* seems to come closest to giving such general information. Many isolated observations on different species of Culicidae are scattered in the literature, and much of this information has been reviewed by Bates (1949) and Hopkins (1952). Many activities of mosquito larvae do not seem to lend themselves to a quantitative approach. Others, e.g. reflex diving, are more readily subjected to experimental analysis. There are a number of excellent quantitative studies on larval responses to a variety of stimuli, notably those of Ivanova (1940), Thomson (1940), Folger (1946), and Thomas (1950).

The present notes are concerned with qualitative descriptions of the behavior and activities of normal fourth instar *Anopheles quadrimaculatus* Say under more or less uniform, and hence highly artificial, laboratory conditions. The data are assembled partly from detailed notes taken from controls in current experiments dealing with the effects of salts, drugs, and poisons on various organ systems in fourth instars. The information is also based on numerous observations made from time to time during the four-year period in which this species has been under study in this laboratory. However, no attempt has been made to elucidate any of the complex factors involved in the behavior observed. Quantitative data on some of the activities listed in these notes will be given in a subsequent series of papers that deal with physiological responses to abnormal stimuli.

METHODS. The larvae of *Anopheles quadrimaculatus* were reared as described by Peffly *et al.*, (1946).

[1] The author is indebted to Mr. J. L. Scheltema for valuable suggestions in connection with this work.

[2] Laboratory of Tropical Diseases.

Both macroscopic and microscopic observations were made. Macroscopic studies were made on both individual specimens and on groups of larvae in beakers, Petri dishes, rearing pans, or in the wells of micro slides. Microscopic observations were made on individual larvae placed in micro slides containing distilled water with and without food. All studies were conducted at 27± 2° C.

Detailed notes were taken only on fourth instars. All ages within this stage were examined, physiological ages being roughly estimated by a method given by Jones (1953).

The terminology and classification used in this study were necessarily arbitrary and are, therefore, tentative.

Results. Fourth instar *A. quadrimaculatus* have at least 14 different types of activities or general behavior patterns under routine laboratory conditions.

(1) Complete rest at surface.—Larvae lie straight and completely motionless suspended at the air-water interface, their spiracular plates, palmate hairs, notched organs, and mouth brushes lightly indenting the surface film. Mechanical forces tend to keep many of them perpendicular to the edge of ordinary glass and enamel containers as pointed out by Renn (1941). However, resting larvae may be seen both parallel to the edge or in the center of containers. They may lie at complete rest with either dorsal or ventral face of the head uppermost, most commonly the former.

(2) Quiescent feeding.—When abundant food is present, larvae lie quietly as described in (1), the ventral face of the head being uppermost after rotation through a 180° angle, with only the mouth parts being in motion. Rotation of the head is usually counter-clockwise. Very frequently the head also moves from side to side in quiescent feeding. When these movements are made in the absence of food they can be termed "imitative."

Nuttall and Shipley (1901) describe rotation of the head in *A. maculipennis* larvae. According to Smith (1914) these rotations are always counter-clockwise. Renn (1941) gives detailed descriptions of "free" ("eddy") feeding, "film," and "interfacial" types of feeding in *A. quadrimaculatus* larvae.

(3) Radius feeding.—Frequently when larvae are quietly feeding as described under (2), their bodies may sway horizontally through a 5–60° arc or momentarily bend to either side, their posterior ends remaining at a fixed point as they feed.

(4) Sub-surface feeding without locomotion.—When little or no food is present in the surface film, larvae have been observed to bend the anterior end of the body downwards, their stigmatic apparatus being still attached to the surface film, and feed either on the bottom of shallow containers or in the intervening space between bottom and surface in deeper containers (figure 1).

(5) Swimming excursion.—Often larvae may be observed to swim forward. Such excursions are of two main types: In (a) "simple excursion" larvae move parallel to the horizontal water film and either do not feed as they float; or, more commonly, they feed after rotation of the head as they move. The second type of excursion may be referred to as (b) "subsurface grazing." In this type of activity they bend downwards as described under (4) and swim about vigorously feeding on the bottom but the head does *not* rotate (figure 1). They engage in this latter type of activity generally only when there are no particles in the surface film.

Smith (1914) describes this activity in *A. punctipennis* larvae: ". . . when feeding on a filament, usually the mouth parts are underneath and the head is bent downwards."

(6) Positional movements. — Larvae, which are resting or feeding at the surface, may often exhibit a variety of complex but slight body movements which mainly seem to keep them properly positioned at the surface. They may move slightly backwards and forwards (generally while feeding vigorously), or move slightly from side to side, or rock along their horizontal axis. Occasionally they may flick the median plate of the stigmatic apparatus or

stretch along the longitudinal axis *in situ*. These movements tend to be spasmodic. In the present study they were observed to make these movements when gently blown about over the surface in a weak air current, or while feeding on a surface containing an excess of food particles.

(7) Homostrophic reflex.—One of the most clearly defined responses given by larvae after a mechanical disturbance is the homostrophic reflex (figure 2). In giving it, the body of the larva still lies parallel to the water surface but bends from its straight position (2a) to assume an S-shape (fig. 2b). When larvae are touched laterally with a pointed applicator stick they tend to bend away from the point of stimulation. However, larvae may be approached with an applicator stick or glass rod and repeatedly stroked along their dorsal surface without eliciting this response. They may even be shifted about by a weak air current or with an applicator stick over a considerable distance without giving this reflex.

If a ripple is made at a distance from a resting or quietly feeding larva that is facing the direction of the stimulus, it generally remains quiet until after the ripple and its reflections have passed and then gives the homostrophic reflex, or else wriggles violently and/or falls to the bottom of a shallow test container. But larvae may maintain the S shape for a long time if the disturbance is continued. Normally they do not feed immediately following the reflex but may do so shortly thereafter while still in the "S" position.

When the container in which larvae are resting or feeding quietly is lightly but sharply tapped, larvae have been sometimes observed to arc the anterior end of the abdomen downward while keeping their stigmatic apparatus, notched organs and head at the surface as shown in figure 3. This response is included tentatively with the homostrophic reflex.

No description of this reflex was found in a survey of the literature on mosquitoes.

(8) Sudden swimming movements.—One of the principal means of locomotion of larvae is through sudden, vigorous, backward-directed swimming movements. Removal of the hairs of the ventral brush on the anal segment did not interfere with these movements. In the present studies swimming movements were mainly observed in larvae deprived of food for a short while, and in larvae which were mechanically disturbed. There seems to be a definite connection between these movements and defecations in freshly starving larvae, for almost invariably they immediately follow defecations. However, when abundant food is present sudden swimming movements do not necessarily follow defecations. Sometimes starving larvae may go into a veritable frenzy of sudden swimming movements, which then closely resemble convulsions. Generally such larvae may be rapidly quieted by feeding them.

Wriggling movements are included under this category because the pattern of locomotion appears to be fundamentally identical. Wriggling tends to last longer than simple sudden swimming movements. Larvae ordinarily begin instant and violent wriggling when the surrounding medium is withdrawn so that they touch the bottom of the container.

(9) Crawling.—When larvae are dried off so as to leave only a thin film of water about them on a glass slide, they make *forward* crawling movements. When completely dried off they cannot move around but are still capable of flipping about vigorously.

Nikolsky (1924) has described the ability of *Anopheles maculipennis* larvae to crawl. He found that they used their "oral appendages," especially the labrum, as points of support and "crawled" by means of peristaltic (forward telescopic) movements.

(10) Reflex "diving."—If *A. quadrimaculatus* larvae are greatly disturbed, e.g. by sudden violent jarring or shaking of the test container, they tend to fall rapidly downward.

According to Nuttall and Shipley (1901), in *A. maculipennis* larvae, the median flap of the stigmatic apparatus ". . . folds suddenly back [as] the animal

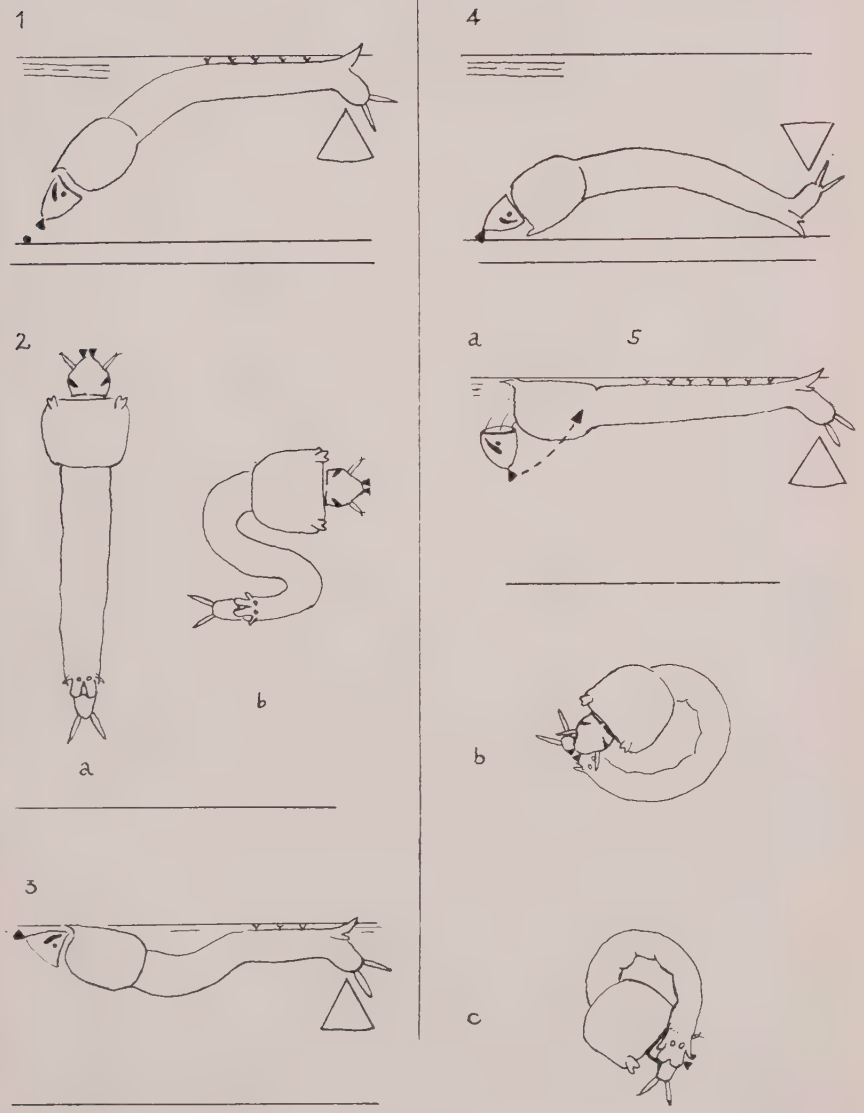

Plate 1.
(Diagrammatic)

FIG. 1.—Lateral view of larva engaging in sub-surface grazing. FIG. 2.—Dorsal view of larvae in (a) normal resting position (complete rest), (b) homostrophic reflex position. FIG. 3.—Lateral view of larva arching anterior end of abdomen downward as a result of mild disturbance (see text). FIG. 4.—Lateral view of larva in state of akinesis. FIG. 5.—(a) Lateral view of larva cleaning about thorax. (b) Dorsal view of larva cleaning about the stigmatic apparatus. (c) Dorsal view of larva showing position assumed in cleaning abdomen.

suddenly darts below. . .". That this is not the case with *A. quadrimaculatus* larvae can be shown after slipping a coverglass over them in a well slide so as to completely exclude them from contact with the air-water interface. When this is done it can be seen that the lateral edges of the median dorsal plate of the stigmatic apparatus curl inwards to form a kind of shallow scoop. The median plate can be elevated by two muscles which are inserted medially at a point directly between the spiracular openings, but this elevation is not an essential feature and can occur without diving being involved. Further, removal of the median dorsal flaps does not alter the ability to fall ("dive") from the surface film, although it does seem to interfere slightly with re-attachment to the surface film after akinesis.

(11) Akinesis.—When larvae fall downward from the surface film in shallow water (less than ½ inch) the body is usually dorsally arched as shown in figure 4. They come to lie on the bottom, generally on their dorsal surface, but have also been observed to fall on their ventral surface in very shallow water. They have even been seen to fall onto their lateral surface (their bodies arched laterally) and briefly swim forwards for a short distance in this position on the bottom of the container. If quiescent larvae are briefly shaken in deep water (more than 2 inches) they fall downwards as described above, but many begin vigorous swimming movements shortly after leaving the surface and return to the air-water interface without ever reaching bottom.

Although akinetic larvae tend to lie quite motionless at the bottom of shallow water, they have been seen to move the mouth brushes, defecate, and give the homostrophic reflex. Rarely, they were observed to rotate the head through 180° but they apparently do not actually feed in this position.

They remain akinetic for only a few seconds or, more commonly, for prolonged periods of time in shallow water. They return to the surface through vigorous swimming movements.

If akinetic larvae are illuminated only from the bottom in a beaker of deep water in an otherwise shaded room, the time required for all in a lot of ten to return to their position at the surface is around 8 minutes even though 50% of them surface in approximately 90 seconds. If, on the other hand, akinetic larvae are lighted only from the top (beam directed vertically down into the open beaker), *all* in a lot of ten surface in from 10–40 seconds. It is noteworthy, however, that larvae at either complete rest or engaged in quiescent or radius feeding did not orient themselves in relation to variously directed beams from the same artificial light; nor do quiet, dark-adapted larvae visibly react to sudden flicking on of a strong beam of light.

(12) Cleaning activities. — *A. quadrimaculatus* larvae perform the most remarkable contortions when engaged in cleaning the body surface (figure 5). The "neck" (cervical membrane), which cannot ordinarily be seen in larvae at complete rest or when they quietly feed, can be stretched outward to such an extent that they can clean about the thorax (figure 5a). In cleaning the abdomen, larvae bend themselves so as to reach and brush the anal papillae and the ventral brush. They usually do this while still attached to the surface by the stigmatic apparatus. They do not ordinarily fall from the surface film when cleaning about the stigmatic apparatus. Mouth brushes are principally used in cleaning but cephalic and thoracic hairs probably aid in the process.

Smith (1914) briefly describes cleaning activities in *A. punctipennis* larvae as follows: "Frequently it [the larva] bends and brushes over its whole body as far as it can reach."

(13) Offensive behavior.—Larvae under crowded conditions frequently appear to "attack" each other, nipping vigorously and repeatedly at different parts of the body. Occasionally two larvae may briefly engage their mouth parts so as to appear to be struggling one with the other. From time to time, two or more larvae have

been seen apparently "attacking" a third one. Not infrequently the third larva is damaged in some way or appears otherwise abnormal.

(14) Molting behavior.—Only two aspects of the behavior prior to pupation will be described. Prior to ecdysial peristaltic movements (forward-directed contractions) themselves, the lateral walls of the last few abdominal segments—along the dorso-pleural line—rhythmically expand and collapse like a bellows, doubtless reflecting internal pressure changes. Backward-directed longitudinal stretches of the body, especially noticeable between the seventh and eighth abdominal segments, may also occur.

Summary and Conclusions. The behavior and activities of normal fourth instar *Anopheles quadrimaculatus* Say as they occur under more or less uniform laboratory conditions are briefly described and categorized as follows:

(1) Complete rest at surface; (2) quiescent feeding; (3) radius feeding; (4) subsurface feeding without locomotion; (5) swimming excursions: (a) simple excursions (b) sub-surface grazing; (6) positional movements; (7) homostrophic reflex; (8) sudden swimming movements; (9) crawling; (10) reflex diving; (11) akinesis; (12) cleaning activities; (13) offensive behavior; and (14) molting behavior.

These qualitative descriptions furnish a basis for quantitative studies on the effects of physiological and toxicological stimuli on different activities.

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The Annual Meeting of the New Jersey Mosquito Extermination Association will be held at Haddon Hall, Atlantic City, N. J., March 9, 10 and 11, 1955.

INVESTIGATION OF SUSPECTED RESISTANCE OF MOSQUITOES TO DDT IN SOUTHERN ONTARIO[1]

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The insecticide DDT, particularly in the form of aerial sprays, has been applied for mosquito control in southern Ontario since 1945. Poor control was reported in certain areas in 1951, resulting in the partial substitution of dieldrin in 1952 and lindane in 1953. Since the aerial operators concerned felt that they were combating a case of resistance to DDT, an investigation was carried out on this point.

In May and August, 1953, a total of 33 collections of larvae were taken in selected localities, particularly Hamilton (treated for 8 years), Toronto, Rondeau Park, and Port Franks (treated for 5 years), and Orillia, Harrow, and Camp Borden (treated for 2 years). Untreated localities selected as controls included Guelph, Hespeler, Ayr, Breslau, and New Hamburg, all in the central argicultural region of southern Ontario, and St. Catharines and Point Pelee. Collections were also made at London and Ipperwash, where only adulticide aerosols had been applied; these areas were classed with the untreated areas.

During May the principal species collected were *Aedes fitchii* (F. & Y.), *A. stimulans* (Wlk.), and *A. excrucians* (Wlk.); several collections contained *A. canadensis* (Theo.), *A. implicatus* Vock. (= *A. impiger* of American authors), *A. cinereus* Mg., and a few specimens of *Culiseta inornata* (Will.) and *C. morsitans* (Theo.). During August the principal species were *Culex pipiens* L., *C. restuans* Theo., and *C. apicalis* Adams, with a single large collection of *Aedes vexans* (Mg.). The species of *Culex* characteristically occurred in the cities of Toronto and Hamilton, whereas the species of *Aedes* were characteristic of the partially wooded, central agricultural regions.

Larvae were transported to the laboratory in 1-gal. square-sided glass jars, and transferred to 10- by 15-in. enamel pans and fed on powdered fox-chow and yeast. Tests were performed on groups of 20 to 50 larvae in the third and fourth instars; to 1 litre of water in a 7- by 11-in. enamel pan, 0.01 to 0.1 part per million of DDT were added in a small amount of ethanol. Those larvae that still could move or had pupated after 24 hr. at 23° C. were counted as survivors. The larvae that were not tested were reared to the adult stage by the method of Ludvik (1953) in screened quart Sealright containers. The adults, divided according to sex, were tested 3 to 5 days after emergence; 0.05 to 1.0 microgram of DDT were topically applied in 0.25 ml. of methanol by the method of Ludvik (1953), with a tuberculin syringe and a 26-gauge hypodermic needle. The mosquitoes that could fly after 24 hr. at 23° C. and 70–95 per cent R.H. were counted as survivors. Control mortalities of adults of *C. pipiens* treated with the solvent alone were 14 per cent for males and 3 per cent for females.

The results are shown in Tables 1 and 2. The collections each represented one of the four following groups: (a) *Culex* spp., (b) *Aedes vexans,* (c) *A. canadensis* mainly, (d) *A. fitchii, A. stimulans,* or *A. excrucians,* or combinations of these

[1] Contribution No. 3232, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada. The results herein reported were obtained by the Entomology Division in a program of studies on the biology and control of biting flies being carried out on behalf of the Defence Research Board, Canada Department of National Defence, and with the co-operation of that organization and other agencies.

[2] Head, Department of Zoology, University of Western Ontario, London, Canada; in the seasonal employ of the Entomology Division, as Entomologist, when this work was performed.

[3] Survey Assistant and [4] Associate Entomologist, Veterinary and Medical Entomology Unit, Entomology Division, Ottawa, Canada.

banded-legged species. The results for each group, which involved up to 7 tests, were combined for treated and for untreated areas.

The figures show that the higher mortalities were obtained with larvae from treated areas as often as with larvae from untreated areas. In the 5 instances where paired assessments were made with larvae from treated and untreated areas, Student's t test yielded a p value of 0.12. In the 9 cases where the assessments on adults were similarly paired, the p value was 0.29. These results are far from showing

Table 1.—Toxicity of DDT to mosquito larvae collected from treated and untreated areas

Species	Area	Percentage mortality at concentration * of				
		0.1	0.05	0.025	0.02	0.01
Aedes fitchii, *A. stimulans*, or *A. excrucians*	Treated	90(30)**	93(30)	..	..	..
	Untreated	86(28)	94(30)	84(25)	..	..
Aedes canadensis mainly	Treated	..	71(21)	..	..	..
	Untreated	93(31)	91(66)	..	..	..
Aedes vexans	Untreated	100(147)	99(148)	96(163)	..	..
Culex pipiens, *C. restuans*, or *C. apicalis*	Treated	99(280)	94(323)	96(181)	46(67)	34(65)
	Untreated	97(34)	..	69(88)	..	..

* Parts per million.
** Total number of mosquitoes in samples indicated by parentheses.

Table 2—Toxicity of DDT to adult mosquitoes collected from treated and untreated areas

Species	Area	Percentage mortality * at dosage ** of				
		1.0	0.5	0.25	0.1	0.05
Females						
Aedes fitchii, *A. stimulans*, and *A. excrucians*	Treated	83(30)***	100(25)	..	..	..
	Untreated	90(348)	94(216)	..	..	..
Aedes canadensis mainly	Treated	100(11)	..	..	..	..
	Untreated	96(78)	..	..	..	..
Aedes vexans	Untreated	..	..	100(12)	99(90)	95(60)
Culex pipiens, *C. restuans*, and *C. apicalis*	Treated	81(41)	86(44)	81(83)	80(98)	71(93)
	Untreated	..	..	..	94(18)	75(20)
Males						
Aedes fitchii, *A. stimulans*, and *A. excrucians*	Treated	..	88(8)	..	..	..
	Untreated	95(61)	98(65)	..	..	..
Aedes canadensis mainly	Treated	100(11)	..	..	..	..
	Untreated	97(18)	..	..	..	..
Aedes vexans	Untreated	..	..	100(25)	100(31)	..
Culex pipiens, and *Culex* spp.	Treated	81(27)	96(53)	92(85)	100(47)	98(44)

* Control mortalities for solvent alone: females, 3 per cent; males, 14 per cent.
** Micrograms per mosquito.
*** Total number of mosquitoes in samples indicated by parentheses.

any significant difference at the 5 per cent level, where p equals 0.05.

The larvae of all the species tested, whether from treated or untreated areas, were more susceptible than a strain of *Aedes aegypti* (L.), laboratory-reared in the absence of DDT, which showed only 68 per cent mortality in 0.1 p.p.m. of DDT. They are very much less resistant than the strains discovered by Gjullin and Peters (1952) in California, where the LD_{50} figures were from 0.05 to 0.08 p.p.m. for *Culex quinquefasciatus* Say, 0.11 p.p.m. for *A. nigromaculis* (Ludl.), 0.15 p.p.m. for *C. tarsalis* Coq., and 0.33 p.p.m. for *A. dorsalis* (Mg.). The adult females of all the species tested in Ontario were more susceptible than females of the laboratory strain of *A. aegypti,* which showed only 74 per cent mortality at a dose of 1 microgram of DDT. They were also more susceptible than the females of *Anopheles quadrimaculatus* Say, studied by Ludvik (1953) in Alabama, for which the LD_{50} was 0.07 micrograms.

Though fragmentary, the results of this investigation indicate that no significant degree of resistance to DDT has yet been developed by *Aedes* and *Culex* mosquitoes in southern Ontario.

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RESISTANCE OF *ANOPHELES SUNDAICUS* TO DDT [1] A PRELIMINARY REPORT

HERBERT A. CRANDELL

Anopheles sundaicus, the principal malaria vector along the coastal areas of the island of Java, Indonesia, has been found in two localities to be resistant to DDT. These localities are the Djakarta coastal area (including the harbor area of Tandjung Priok) and the city of Tjirebon which is on the coast approximately 200 kilometers east of Djakarta. Further investigations are in progress to include other areas of Indonesia and other vector species.

The possibility that resistance to DDT may be developing in the Djakarta coastal area was first suspected when it was reported that "mosquitoes" in that area were not being killed by the DDT residual applied in malaria control spraying operations. This report was based on the observation that considerable numbers of "mosquitoes," collected from surfaces sprayed with DDT, survived the 48-hour

[1] These investigations are under the joint sponsorship of USOM in Indonesia and the Malaria Institute of the Ministry of Health, Djakarta, Indonesia.

holding period. These "mosquitoes" proved to be *Anopheles sundaicus*. A later but even more convincing indication that *A. sundaicus* may have developed resistance to DDT was the failure of the DDT residual spray program in the Djakarta coastal area to effect control of, or even to reduce appreciably the incidence of malaria. This is evidenced by the following parasite indices for infants under 1 year of age for five kampungs (villages) in that area:

Infant Blood Smears

Year	Number examined	Number positive	Percent positive
1952 (Before spraying)	350	66	18.8
1953 (After first spraying)	350	61	17.4
1954 (After second spraying)	285	47	16.5

Numerous tests for the presence of resistance to DDT have been made in the past several months in various parts of the islands of Java and Madura. Essentially the tests consist of confining wild-caught anopheline mosquitoes on previously-sprayed plywood panels for 30-minute exposure periods. Exposed mosquitoes are then transferred to holding-cages and mortality counts made at the end of 24 hours. Unsprayed panels serve as checks.

The results of tests made thus far indidate that—

(1) *Anopheles sundaicus* in the Djakarta coastal area and in the city of Tjirebon are resistant to DDT even at dosages of as high as 4 grams per sq. meter;

(2) limited data indicate *sundaicus* in the Djakarta coastal area to be approximately 23 times, and in Tjirebon 27 times as resistant to DDT as *sundaicus* from unsprayed areas;

(3) this resistance is apparently an "acquired" or "developed" resistance in contrast to a "natural" resistance;

(4) females are approximately 1.7 times more resistant to DDT than males from the same area;

(5) there is no evidence of resistance to DDT in other areas of Java or on Madura;

(6) as yet no other anopheline species have shown any indication of resistance to DDT, even when from the same areas where *sundaicus* has developed resistance.

Dieldrin at a dosage rate of one-fourth (0.25) gram per sq. meter was found in panel-tests to be effective against the DDT-resistant strain of *sundaicus*—one hundred per cent mortalities being consistently obtained in tests made in conjunction with the DDT-resistance investigation. On the basis of these results Dieldrin was recommended for use in the areas where *sundaicus* has shown resistance to DDT. In view of the already-established resistance of *sundaicus* to DDT, however, it was believed advisable to use a dosage rate of 0.5 grams of Dieldrin per sq. meter (1.25% suspension). Residual spraying operations were begun with Dieldrin in the Djakarta coastal area in March of this year (1954). Results thus far indicate that Dieldrin is proving effective in controlling malaria in the Djakarta coastal area, where DDT failed to provide control.

As stated earlier, the resistance studies are still in progress. There remain many areas to be visited and other vector species to be tested. Upon completion of these investigations a final report will be submitted which will include specific data on results obtained and a detailed description of equipment and procedures used.

THE FAILURE OF THE ANTIHISTAMINE CREAM PYRIBENZAMINE TO ALLEVIATE REACTIONS FROM BITES OF THE MOSQUITO *AEDES AEGYPTI*[1]

J. A. McKIEL,[2] A. S. WEST,[3] AND G. B. REED[4]

Recently O'Rourke and Murnaghan (1953) have published results to show that a topically applied antihistamine, pyribenzamine, decreases not only pruritus but also the immediate cutaneous reaction to the bites of *Aedes aegypti* (L). Fourteen of thirty reactors experienced relief of pruritus associated with the immediate reaction and four out of five with the delayed reaction. In addition ten out of thirty subjects exhibited reductions in size of the immediate cutaneous reaction.

Previous claims for relief of insect bite reactions through the use of antihistamines have varied and have been based on results obtained with very few subjects or with an unstated number of subjects (Gordon and Crewe, 1948; Salva Miquel, 1949; Straus, 1949; Gordon, 1951; Rockwell and Johnson, 1952). In no report was the number cited as large as employed by O'Rourke and Murnaghan. Studies of the local effects of antihistaminic ointments on the histamine wheal led Perry (1947) and Peck *et al.*, (1950) to conclude that topical application had relatively little effect and that very little if any of the antihistamine is absorbed through the intact skin.

During early phases of an extended study on the nature of the mosquito bite reaction now in progress, sporadic tests with antihistamines were made. These limited tests failed to indicate that any significant relief was obtained. It appeared possible that the results obtained by O'Rourke and Murnaghan might have been influenced by the methods used. In their procedure, two mosquitoes were allowed to feed to repletion on the flexor surface of the forearm at sites about six inches apart. Immediately following, a two per cent pyribenzamine cream was massaged into one of the sites and the other was left untreated as a control. No statement was made as to whether the sites were randomized with respect to treatment. The technique might be criticized on two grounds, namely, the failure to use a control cream, and the apparent lack of randomization. Since no treatment was given the control bite it is apparent that this area was not massaged. Also, the subject appears to have known which site had received the antihistaminic treatment. If this was the case, a well recognized source of bias was permitted which could be reflected in the subject's interpretation of degree of pruritus at each site. Regarding the need for randomization, Becker and Rappaport (1948) have found in ragweed-sensitive subjects that sites near the cubital fossa are more reactive to constant doses of ragweed antigen than sites near the wrist. Similar results were obtained by Swain and Becker (1953) with constant doses of histamine. Presumably mosquito bite reactions might show the same variation. The use of randomization and a control cream also has the advantage of removing bias on the part of the observer of the bite reactions since he will be unaware of the kind of treatment applied at a particular site. Since reactions to mosquito bites exhibit considerable variation even for the individual, it is most important to eliminate as many sources of error as possible.

METHOD. One hundred and twenty-six medical and biology students from Queen's University, Kingston, together

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[4] Superintendent, Defence Research Kingston Laboratory.

with twenty associates from this laboratory served as volunteers. Two methods of applying treatment were tried. In the first, O'Rourke and Murnaghan's procedure of applying the antihistamine immediately after the receipt of mosquito bites was followed. Since, however, the application of the antihistamine prior to the test substance (histamine, allergen) appears to be the usual method for assessing antihistamines (Perry 1947; Peck *et al.*, 1950; Feinberg *et al.*, 1950, p. 96), a second test was made employing this procedure.

(1) *Post-biting treatment.* Eighty-two subjects were tested. Mosquitoes were confined individually in 1″ x 8″ vials. A vial was applied to the flexor surface of each forearm and the mosquitoes were allowed to feed to repletion. Immediately after the subject was bitten, approximately 2 grams of 2 per cent pyribenzamine cream [1] were applied on one bitten area and a similar amount of control cream of comparable consistency (dermabase [2]) was applied on the other. The creams were massaged into the skin over an area of approximately 1.5 inches in diameter centered on the bite. The selection of right or left arm for treatment with antihistamine was random and not known either to the subject or to the observer of the reaction.

(2) *Pre-biting treatment.* Sixty-four subjects were tested. The creams were applied, massaged for three minutes and the areas outlined with a ball-point pen. After an additional seven minutes, the creams were washed off with water, dried and the sites exposed to mosquito bites as in the previous trial.

Reactions were recorded one-half hour and twenty-four hours after the bites were received. All observations were made by the same person. Wheals and erythema were measured longitudinally and transversely with calipers accurate to 0.1 mm. Wheals were recorded to the nearest tenth millimetre and erythema to the nearest millimetre. The degree of pruritus was recorded by the subject for each arm using +, ++, or +++. These have no absolute comparative value between subjects but merely indicate similarities or differences in pruritus between the two sites for an individual. In the first test, any pruritus which occurred between the beginning of the biting and the application of creams was ignored and pruritus was recorded only if it occurred following the massage of creams.

Results. Not all subjects developed reactions to the bites (numbers positive are shown in Tables 3 and 4). There were also several instances in which immediate reactions developed on one arm but failed to appear on the other. These inconsistent reactions are summarized in Table 1.

Table 1.—Variations in immediate reactions between arms of individual subjects

Site	Number of subjects with negative reactions at one site and positive at the other	
	Post-biting	Pre-biting
Antihistamine	6	3
Control	3	4

The occurrence of negative and positive reactions on one individual cannot be correlated with the antihistaminic treatment but only emphasizes the variations in reactions which may occur.

Immediate reactions at the antihistamine and control sites are compared in Table 2 on the basis of mean diameters of wheals and erythema for all reacting subjects. It is apparent from the results that the antihistamine, applied either before or immediately after the bite, had no influence on wheal or erythema. In Table 3, immediate reactions are compared on the basis of numbers of individuals who exhibited particular types of reactions. Table 4 compares delayed reactions also on the basis of numbers of individuals.

[1] Ciba Company Limited, Montreal.

[2] Marcelle Pharmaceuticals, Chicago. This cream is a stabilized emulsion of fatty acid esters and alcohols.

TABLE 2.—Mean diameters of immediate wheals and erythema at sites treated with antihistamine and control creams

	Wheal		Erythema	
	Antihistamine	Control	Antihistamine	Control
Post-biting treatment				
Mean diameter (mm.)	6.8	6.8	32	33
Standard deviation	3.2	3.5	13	12
Pre-biting treatment				
Mean diameter (mm.)	6.1 *	6.5 *	30	31
Standard deviation	3.0	3.1	16	15

* The difference between these diameters was not statistically significant at the 5 per cent level.

TABLE 3.—Comparison, by number of individuals, of immediate reactions at sites treated with antihistamine and control creams

			Unequal reactions at two sites	
	Number of reactors	Equal reaction treated and control sites	Less at control-treated	Less at antihistamine-treated
Post-biting treatment 82 Subjects				
Pruritus	49	16	15	18
Erythema	48	4	24	20
Wheal	71	6	32	33
Subjective estimation	71	39	16	16
Pre-biting treatment 64 Subjects				
Pruritus	47	18	15	14
Erythema	47	4	22	21
Wheal	60	7	24	29
Subjective estimation	60	36	10	14

TABLE 4.—Comparison, by number of individuals, of delayed reactions at sites treated with antihistamine and control creams

			Unequal reactions at two sites	
	Number of reactors	Equal reaction treated and control sites	Less at control-treated	Less at antihistamine-treated
Post-biting treatment				
Pruritus	11	3	3	5
Erythema	24	12	8	4
Papule	59	42	6	11
Subjective estimation	59	43	8	8
Pre-biting treatment				
Pruritus	13	4	5	4
Erythema	33	20	6	7
Papule	50	39	5	6
Subjective estimation	50	37	6	7

The term "Subjective estimation" is here used to mean an over-all evaluation of the total reaction at each site and was made by observing the reactions with both arms held side by side.

Discussion. The above tables show that two per cent pyribenzamine cream has exerted no significant effect on reactions to bites of the mosquito, *A. aegypti*. The disagreement between these results and those published by O'Rourke and Murnaghan can possibly be attributed to differences in technique which have already been discussed. In our test which followed O'Rourke and Murnaghan's method of applying creams after the bites were received, it was frequently noted that massage of either cream decreased or eliminated pruritus. It therefore appears that the massage of a cream is more important in relieving pruritus from mosquito bites than the presence of pyribenzamine in the cream.

Acknowledgment

We wish to express our thanks to the subjects who volunteered for this experiment.

Summary. Two per cent pyribenzamine cream was tested against a control cream, dermabase, for its ability to relieve reactions to mosquito bites. One hundred and forty-six volunteers were used for the test. The creams were employed in two ways, (1) applied immediately after biting and (2) applied ten minutes before biting. In neither method of treatment was the antihistamine superior to the control cream in relieving pruritus or the cutaneous reaction.

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THE EFFECT OF POPULATION DENSITY AND OF NaCl CONCENTRATIONS IN TEST SERIES IN LABORATORY EXPERIMENTS WITH OVIPOSITING *AEDES AEGYPTI* [1]

ROBERT C. WALLIS [2]

During past years variable results have been reported from laboratory experiments concerning the preference or selection among saline oviposition sites by *Aedes aegypti*. Two factors that have been variable in works reported to the present time are the density of the adult population in the cage at time of testing, and the types of solutions used in experiments. The purpose of this study was to determine the effect which variations of these two factors might have on egg distribution among saline oviposition sites.

As early as 1919, Fielding reported that *Aedes aegypti* in the laboratory would oviposit on water containing as high as two per cent NaCl if fresh water was removed from the cage. Later, Macfie (1921) reported that this species would not lay eggs on sea water. Woodhill (1946) in experiments with *A. aegypti*, used dilutions of sea water in test series and found a distinct preference for distilled water over dilutions representing .5 to 3.5% salinity in his test series of oviposition sites. In his observations, a mean of 43.1% of eggs were deposited on distilled water, 33.4% of eggs on .5% saline concentration, 18.2% of eggs on 1.0% concentration, 3.2% of the eggs on 1.75% concentration, and no eggs were oviposited on 3.5% solution. This work of Woodhill's has been the most complete study reported up to the present time concerning the response of *Aedes aegypti* to salinity in oviposition water. There have been no studies of the effects of population densities on the oviposition response or of the ranges of salinity that would be preferred or tolerated if more choices of salinity concentrations were available in test series.

MATERIALS AND METHODS. The strain of *A. aegypti* used in these experiments has been maintained in the Johns Hopkins Insectory since before 1949, and originated from eggs obtained from the Laboratory of Tropical Diseases, National Institutes of Health, Bethesda, Maryland. From the stock colony, gravid females were transferred to experimental cages, 3 x 3 x 2.5 feet in size. All tests were run at room temperature of 27 ±3 degrees C. In testing procedures, a series of test sites was placed in the mosquito cage during an oviposition period of 24 hours. During this period the locations of test sites were changed around to prevent a "position preference," and nearly saturated humidity conditions were maintained in the cages to reduce evaporation of test solutions. Each oviposition site was a 65 sq. cm. petri dish containing 80 ml. of test solution. Strips of white filter paper 3 x 16 cm. were placed around the inner side of the dishes in such a manner that 2 cm. of moist paper extended above the water surface providing oviposition areas of 32 sq. cm. each. To reduce the amount of salt concentration by capillarity in the paper, these strips were inverted at the end of twelve hours.

Saline solutions were made up by volumetric dilution with distilled water of stock six per cent (by weight) sodium chloride solutions. Sodium chloride was of Reagent grade, molecular weight 58.45, commercially produced by Merck & Company, Rahway, New Jersey. In preparing

[1] This work is part of a research program conducted under the direction of Dr. L. E. Rozeboom, and submitted as an Sc.D. dissertation to the Johns Hopkins School of Hygiene and Public Health, Baltimore, Maryland. It was aided in part by a scholarship grant from the Johns Hopkins University, and in part by a fellowship from the National Microbiological Institute, the U. S. Public Health Service, Bethesda, Maryland.

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the stock solutions, dry, crystalline NaCl from moisture-proof sealed bottles was weighed out on a chemical balance to within one milligram. Six per cent stock solutions were stored in clean brown glass bottles. Saline dilutions of required concentrations were kept in tightly stoppered one-liter flasks for everyday use. Solutions of over three per cent were made up at the time they were needed.

Even though an attempt was made to minimize concentration of the test solutions due to evaporation by maintaining as nearly saturated conditions of humidity as possible in the cages, in a series of control tests it was found that under the conditions in which the experiments were carried out there was a volumetric loss of fluid from the 80 ml. of solutions used that ranged as high as 12 ml. in a 24-hour period. This resulted in a concentration of the test solution; therefore, dilutions of fractions of a per cent were not used in testing below the 0.25 level; furthermore, all values of saline concentrations in test dishes refer to the per cent of NaCl at the beginning of an experiment, and there was sufficient difference allowed in a test series so that while the actual mean per cent of NaCl concentration for the 24-hour test period was somewhat higher than that at the beginning of an experiment, there was actually no overlapping of concentrations in a test series of saline solutions. For example, 80 ml. of a test solution of 0.25 per cent saline contained 0.20 gms. of NaCl at the beginning of an experiment. Under the mean range of conditions of low humidity, 6 ml. of solvent was lost by evaporation, leaving 0.20 gms. of solution in 74 ml. of solvent at a concentration of 0.27 per cent saline.

In the first experimental procedure, in order to determine the effect of different numbers of mosquitoes used in oviposition experiments, a number of tests were made in which the order and magnitude of the saline series and the cage size did not vary, but the numbers of females ovipositing were varied in successive trials. In these, eight test oviposition sites were placed in the cage for the 24-hour oviposition period. These sites were dishes containing solutions of 0 (distilled water), 0.25, 0.5, 0.75, 1, 1.5, 2, and 3 per cent saline for each oviposition period. During the first period of egg-laying, two females were allowed to oviposit. Resulting eggs were counted and their distributions recorded. Subsequent groups of 10, 20, 40, 100, 200, and 350 were allowed to oviposit on the same kind of series. The results were tabulated as in Table 1 in order to determine the approximate point at which the range of spread of egg-laying on the saline series remained constant.

In the second experimental procedure, a series of tests were run to determine the effect of different ranges of salinity concentrations used in oviposition tests and to determine the sensitivity of ovipositing females to salinity in the water. In these tests, the standard cages were used, the adult population (200) kept constant, the combinations of solutions comprising the test series varied, and the number of choices of sites in the series was varied in successive trials.

Saline series of the following combinations were used:

Series A. 0, 0, 0, 0.125 percent
Series B. .0, 0.125, 0.25, 0.5, 1, 2, 2.5, 3 percent
Series C. 0, 0.25, 0.5, 0.75, 1, 1.5, 2, 2.5 percent
Series D. 0, 0.5, 0.75, 1, 1.5, 2, 2.5, 3 percent
Series E. 0, 1, 2, 3 percent

The number of eggs on the dishes in each series was determined and the percentage of eggs for each dish within a series recorded as shown in Table 2.

Results. Table 1 represents a summary of the results of the tests with various adult densities of ovipositing females. The percentage of eggs deposited on each concentration of saline is given as well as the number of eggs upon which the percentage is based. These results show that when two mosquitoes oviposited, as in the first test, the distribution of eggs extended to only the 0.5 per cent concentration. In the second test, 10 mosquitoes oviposited, distributing their eggs in a range up to 0.75 per cent. In the third, 20 oviposited with a range to 1 per cent. In the fourth, 40 oviposited with no extension of the

Aedes aegypti on a saline series

No. of females ovipositing—		2	10	20	40	100	[illegible]	350
Dish No.	% NaCl	Percentage of eggs oviposited on each dish						
1.	0*	45.4	16.6	11.4	15.5	13.2	13.4	[illegible]
2.	0.25	51.3	40.7	48.9	50.8	51.5	45.1	42.1
3.	0.5	3.3	25.5	16.8	14.5	19.6	22.7	20.7
4.	0.75	[illegible]	7.2	[illegible]	[illegible]	[illegible]	14.2	19.4
5.	1	0	0	4.7	8.4	5.2	4.6	1.9
6.	1.5	0	0	0	0	0.5	0.2	[illegible]
7.	2	0	0	0	0	0	0.1	[illegible]
8.	3	0	0	0	0	0	[illegible]	[illegible]
Total eggs		172	580	1592	2861	4204	[illegible]	[illegible]

* Distilled water.

Table 2—The percentage distribution of egg deposited by *Aedes aegypti* on saline solutions in test series with different concentrations of NaCl solutions

Conc., % NaCl	0	0	0	0.125	0.25	0.5	0.75	1	1.5	2	2.5	[illegible]	Total No. eggs
Series A	23.9	24.3	24.4	26.7	..	..	..	..	..	..	..	..	1617
Series B	..	..	24.1	46.4	21.4	7.3	0.8	0	[illegible]	[illegible]	..	..	5489
Series C	..	..	12.2	..	50.3	19.8	11.8	5.1	[illegible]	[illegible]	[illegible]	[illegible]	1686
Series D	..	..	57.0	..	..	27.0	14.0	2.0	[illegible]	[illegible]	[illegible]	[illegible]	7058
Series E	..	..	94.3	..	..	..	..	5.4	..	[illegible]	..	[illegible]	4140

range. In the fifth, 100 oviposited with a range to 1.5 per cent. Tests 6 and 7 showed that doubling and more than tripling the number of mosquitoes resulted in extending this range of distribution to no more than 2 per cent, and then only 0.1 per cent of the eggs were on this concentration. These trials showed that the distribution of eggs on a series of saline sites was affected very little by increasing the number of ovipositing females in the test. The proportion, or percentage of eggs deposited on the various concentrations, was very consistent when between 10 and 350 mosquitoes were used. There was some extension of range of distribution among the larger populations, but when their numbers were increased beyond 20, the extension of range of the distribution involved not more than 0.5 per cent of the eggs deposited.

Table 2 shows the percentage distribution of eggs deposited on each concentration of solution and the numbers of eggs on the entire series upon which the percentage was based. The results demonstrated the marked variation in the distribution of eggs that could be obtained from different numbers of concentrations in the test series. In series A it was intended to determine only whether the 0.125 per cent saline would be differentiated from distilled water; such a distinction was not made. In series E, 94.3 per cent of the eggs were deposited on the distilled water when no other choice was given in the series below the one per cent concentration. Series D indicated that the majority of eggs were again deposited on distilled water when no other concentration was available below 0.5 per cent. It could be concluded from these results that distilled water was preferred for oviposition. However, if another concentration amounting to one-half of the 0.5 solution was added as in series C, the majority of eggs were deposited on the saline concentration rather than on distilled water. In this series the range of distribution extended to 1.5 per cent, and at the one per cent concentration was comparable to the one per cent distribution in results of Series E. Series B indicated the same peak of distribution above the distilled water level, but in this series the range extended to only 0.75 per cent, or one-half as high as in Series C. Series A shows a possible reason for this, in that when the 0.125 concentration was tested in a series of distilled water sites no differentiation was made, and egg deposition occurred in comparable amounts.

Discussion. The results of the first procedure of varying the population in oviposition selection tests show that during the testing period eggs will be deposited on a series of test solutions in a representative distribution regardless of the numbers of adults in the test as long as a reasonable number is used. This may be from 10 to 350, and the only change in distribution with the larger numbers will be a slight extension of the range of saline concentrations utilized by the mosquito.

In the first series of tests the distribution of eggs among the test sites did not coincide with the results obtained by Woodhill (1946) in his tests using dilutions of sea water. Throughout the replications in the first tests, more eggs were always deposited on the 0.25 per cent NaCl solution than on the distilled water although it was expected, following Woodhill's distribution curve, that there would be more on the distilled water. However in the second series of tests, in which the number of choices and the saline concentrations in the test series were varied, and the conditions were comparable to those used by Woodhill, the results coincided very closely with his results. When only concentrations of 0.5 per cent or higher were available in the series, the mosquito deposited more eggs on the distilled water than on any saline solution. When lower concentrations were available in the test series more eggs were deposited on the low saline concentration than on the distilled water, and the mosquito actually preferred 0.25 per cent NaCl solution over distilled wated. Therefore, low concentrations of saline are preferred by *Aedes aegypti* and high concentrations are repellent.

The results shown in Table 2 give an

indication of the chemosensitivity of the mosquito when NaCl is used in the test solution. No differentiation was made between 0.125 per cent NaCl and distilled water, but when a geometric series of concentrations was used in the test in which distilled water, 0.125, 0.5 and higher percentages of NaCl solution were available, the 0.25 per cent solution was obviously selected. This indicates that in this range of concentrations the mosquito can distinguish between NaCl solutions of at least 0.02 (M) difference. The ability of the mosquito to detect this slight difference indicates a degree of sensitivity definitely associated with contact chemosensitivity rather than a general chemical sensitivity. It must be remembered, however, that these demonstrated differences do not represent the smallest that the mosquito can detect, but rather the smallest that have been demonstrated for it; and they represent those involved with the oviposition response of the female. It is quite possible that much smaller differences can be detected, but are not sufficiently repellent to cause the mosquito to seek other oviposition sites.

SUMMARY AND CONCLUSIONS. Testing procedures were carried out to determine the effect of varying the density of adult populations as well as the nature of the saline test series in oviposition experiments with *Aedes aegypti*. The distribution of eggs among saline test sites was affected very little by increasing the population of ovipositing females from 10 to 350 except for a slight extension of the range of salinity concentrations used for egg deposition. On the contrary, varying the composition of the series of saline test sites caused considerable difference in the distribution of eggs among the sites. In low concentrations, saline solutions are acceptable to *Aedes aegypti* for oviposition (0.25 per cent NaCl solution is actually preferred over distilled water), but are repellent in high concentrations. In the low range of concentrations, the mosquito differentiated between saline solutions in a geometric series which varied by only 0.02 M. differences in concentrations—indicating a degree of sensitivity associated with contact chemoreceptors rather than a general chemical sensitivity.

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NOTES ON *CHRYSOPS*, OR DEER FLIES (TABANIDAE, DIPTERA) OF NEW ENGLAND

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This is the first of a series of reports on insects of public health importance in the New England States as the result of surveys made by the Public Health Service during 1951–53.

The collector's initials are given in parentheses when numerous collections were made: C. P. Alexander (CPA); E. I. Coher (EIC); Herbert Knutson (HK); John C. Kuschke (JCK); and Frank R. Lisciotto (FRL). When only a few collections were made by an individual, or if the collector is unknown, the name of the organization which possesses the specimens is ordinarily given: Maine Forest Service (MFS); University of Massachusetts (UM); University of Rhode Island (URI); Boston University (BU). When data from the literature are included, the source is indicated by a letter in parentheses: Blickle, 1953 (B); Bromley, 1952 (Br); Fairchild, 1950 (F); Johnson, 1925 (J); Philip, 1947, 1950 (P).

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All collection records listed refer to adult specimens. Ordinarily, no indication is given as to the number of specimens collected. The Roman numeral indicates the month, the second number the day of the month, and the third number the year.

Data on the more common species are lumped while those of rarer species are given in detail. Data previously published are only briefly summarized, and are in-

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cluded only when they contribute materially to the geographical and seasonal distribution picture.

The deer flies have not been extensively studied in New England. Blickle (1954) and Fairchild (1950) published annotated lists for New Hampshire and Connecticut, respectively. Johnson (1925) listed certain collection records for New England. The present study lists thirty-seven species and two subspecies for New England. New state records are starred (*).

Of the biting insects which develop in water or very moist conditions, the deer flies generally rank as a human pest behind the mosquitoes, blackflies, and punkies (Heleidae=Ceratopogonidae) and ahead of the horse flies. In southern New England deer flies exceed the punkies in importance except locally along the coast. In general, they are slightly more abundant in northern than in southern New England. In northern New England they are called "moose flies" and locally "dog flies." They like to attack particularly in the head and neck region.

Chrysops aberrans Philip. ME.: Bar Harbor, VII.21.19 (J); Princeton, VII. 14.52 (HK); Richville, VII.12.52 (HK). N.H.: six localities, VI.15-IX.9 (B). VT.*: Coventry, abundant VII.23.52 (Shannon Fly Trap, EIC); Sand Bar State Park, VIII.7.52, VII.30.52 (Shannon Fly Trap, 60 specimens entered trap until 8 P.M. and were biting in trap in second growth swampy woods at Lake Champlain, EIC); Grand Isle, VII.9.04 (A. P. Morse). MASS.: Auburndale, VII.16 (J); Fall River, VII.22.05 (J. A. Cushman); Hyannis, VIII.4.40 (CPA); Montague, VII.23. 51 (EIC); Newton, VII.23.50 (A. Feldman); Springfield, VII.13.05 (J); Wellesley, VIII.8.07 (BU). R.I.: (P). CONN.: (P). Resume: all states; extreme dates VI.15–IX.9.

The early records above were probably included as *striata* in Johnson's (1925) list.

C. aestuans van der Wulp. VT.*: Sand Bar State Park, VII.30.52 (Shannon Fly Trap, EIC).

C. amazon Daecke. ME.*: Casco, VI. 19.51 (JCK). N.H.: three localities, VI. 50–VII.13 (B). MASS.: North Saugus, VII.17.06 (J).

C. atlantica Pechuman. N.H.: Hampton, VII.1–VIII.21 (B). MASS.: nine localities, VII.17 – VIII.31 (Pechuman, 1949). R.I.: Kingston, VII.18.47 (URI); Westerly, VII.18 (Pechuman, 1949). CONN.: Lyme, VI.27 (Pechuman, 1949).

C. beameri Brennan. MASS.: Woods Hole (F).

C. callidula Osten Sacken. ME.: Morrill, VII.15.52 (MFS). N.H.: six localities, VI.12–VIII.4 (B). VT.*: Sand Bar State Park, VII.30.52 (EIC). MASS.: Amherst, Boston, Chatham, Chicopee, Eastham, Holyoke, Hyannis, Longmeadow, Mt. Tom, Montague, Northampton, Northboro, Springfield, Stockbridge, Sunderland, West Springfield, West Yarmouth, Winchendon, VI.16–VIII.1 (J, UM, EIC, C. A. Frost). R.I.*: Coventry, Kingston, Providence, Rockville, VI.12–VII.7 (HK, URI, Dow and Blake). CONN.: many localities, VI.4–VIII.2 (F); Putnam, V.15. 33, V.18.33 (CPA); Willimantic, VII.2. 52 (HK). Resume: all states; extreme dates V.15–VIII.2.

This is one of the most abundant species in southern New England in the open woodlands. It is less common in northern New England.

Philip (1931) listed the larval habitat as temporary ponds, marshes with indefinite shoreline, and running water.

C. carbonaria Walker. ME.: Casco, VI.19.51 (JCK); Mt. Desert, VI.21.35, VI.23.35 (CPA); Norway (P). N.H.: Lower Pantook, VI.25.52 (FRL); Third Connecticut Lake, VI.24.52, VII.9.52 (EIC and FRL); Twin Mt., VI.22.50 (HK); White Mts., VI.13.36, VI.22.36 (CPA); Mt. Monadnock, VI.22.52 (A. Feldman); twelve localities, V.7–VII.14 (B). VT.*; Downer State Forest, VI.16.52 (EIC); Groton State Park, VI.5.52 (EIC); Lake Willoughby, VI.17–29.45 (CPA); South Troy, VI.12.52 (EIC). MASS.: Amherst, Brewster, Chicopee, Leverett, Mt. Toby, Mt. Tom, Sunderland, V.31–VII.3 (UM, EIC). R.I.: Kingston, VI.15.19, VI.16.42 (URI). CONN.: New Haven, VI.6.36

(UM); eight localities, V.31–VI.27 (F, Br). Resume: all states; extreme dates V.7–VII.14.

Blickle (1954) lists this as an abundant and economic species in New Hampshire in early summer. It is much more abundant in northern than in southern New England. This species usually heralds the beginning of the deer fly season.

Stone (1930) collected larvae in mud among dead leaves and sticks, often under the water, and along the margins of streams and ponds. He took pupae in compact mud, several feet back from the water, just below the surface.

C. celer Osten Sacken. ME.: Casco, VI. 19.51 (JCK); Mt. Desert, VI.27.38 (UM); Princeton, VII.14.52 (biting in rain, HK); Roxbury, VII.13.52 (HK), VII.18.51 (JCK). N.H.: eight localities VI.1–VII.23 (B). VT.: Cornwall, VI.13.36 (R. Dow); Groton St. Park, VII.1.52 (EIC); Jacksonville, VI.28.37 (H. D. Pratt); Missisquoi Refuge, VII.15.52 (EIC); Sand Bar State Park, VII.30.52 (Shannon Fly Trap, EIC). MASS.: Amherst (UM); Ashland, VI. 10.41 (C. A. Frost); Chicopee (UM); Holyoke (UM); Sunderland, VI.6.51 (EIC); Waltham (UM). R.I.: Cumberland, VI.3 (URI); Kingston, VI.23, VI.29 (URI); Providence (URI). CONN.: many localities VI.26–VII.4 (F, Br). Resume: all states; extreme dates VI.1–VII.30. It occurs at about the same density throughout New England.

Stone (1930) took larvae in muddy margins of ponds and sluggish woodland streams, among decaying vegetation. Philip (1931) classified the larval habitat as running water and temporary ponds.

C. cuclux Whitney. ME.: Augusta, VI.18.27 (UM); Casco, VI.18.51, VI.19.51, VI.20.51 (JCK). N. H.: nine localities, V.10–VII.14 (B). VT.: Bradford, VI.5.53 (HK). MASS.: Acton, VI.7.30 (BU); Amherst, V.26.33 (UM); Sunderland, VI.6.51 (EIC). CONN.: eight localities, V.20–VI.24–29 (Br, F). Resume: all states but Rhode Island, extreme dates V.10–VII.14. It occurs at a higher density in northern New England and has been observed attacking in large numbers near Casco, Maine.

C. cursim Whitney. N. H.: Milford (J). MASS.: W. Peabody, VII.13.11 (J); R.I.: Coventry, VII.19.52 (HK); Providence, VII.4 (URI).

C. delicatula Osten Sacken. ME.: Bethel, VII.12.52 (HK); Naples, VII.12. 52 (hovering near skin before biting, HK); Richville, VII.11.52 (HK). N. H.: nine localities, VII.12 – VIII.14 (B). MASS.: Amherst (UM); Martha's Vineyard, VI.27.30 (BU). CONN.: three localities, VI.14–VII.4 (F). Resume: all but Vermont and Rhode Island, extreme dates VI.14–VIII.14.

C. dimmocki Hine. N. H.: Lee, VII.8 (B). MASS.: East Sandwich, VI.20–VIII.28 (UM); Falmouth, VI.15 (UM); Harwich, VII.29.51 (HK); Longmeadow (J). R.I.: Kingston, VI.29.52 (HK). CONN.: Stamford, VI (Br). Resume: all but Maine and Vermont; extreme dates VI.15–VIII.28.

C. excitans Walker. ME.: Brownville Junction, VII.14.52 (HK); Mt. Desert, VI.18, VI.23 (CPA); Mt. Katahdin, VII. 14.52 (MFS). N. H.: Third Connecticut Lake, VI.24.52 (EIC and FRL), VII.9.52 (EIC); Lower Pantook, VI.25.52 (EIC and FRL); sixteen localities, VI.3–VII.12 (B). VT.: East Roxbury, VI.26.52 (EIC); Groton State Park, VII.1.52, VII.16.52 (EIC); MASS.: Barnstable, VI.22 (UM); Chicopee, V.31 (UM); Mt. Toby, VI.10 (H. D. Pratt); Provincetown, VI.19 (UM). R. I..: Kingston, VI.18.42 (HK). CONN.: Avon and Putnam, VI.15–VI.27 (F). Resume: all states; extreme dates V.31–VII.18.

Blickle (1954) lists this as an abundant and economic species in New Hampshire in early summer. It is much less common in southern New England. In New Hampshire this species was very abundant and attacked fiercely.

C. flavida Wiedemann. MASS.: Long Pond, VII (UM); Martha's Vineyard VI.27.30, VII.23.30, VIII.11.35, VIII.13.35 (BU); Nantucket, VII.19.26, VIII.6.28, VIII.8.29, VIII.20.29, IX.8.26 (BU); IX.5

(UM). R. I.: (P). CONN.: five localities, VI.9–VIII.8 (F).

This species seems to be confined to the coastal area of New England.

C. frigida Osten Sacken. ME.: Eastport, VII.15.52 (HK); Orono (UM). N. H.: six localities, VI.11–VII.14 (B). VT.*: Groton State Park, VII.1.52, VII. 31.52 (EIC). MASS.: Belchertown, (UM); Martha's Vineyard, VI.4.32 (BU); Natick, VI.13.37 (C. A. Frost); Nantucket, VI.23.27, VI.24.29, IX.14.28, VII. 25.28 (BU); Peru, VI.4, VI.7 (FRL); Sherborn, VI.18.29 (♂ and ♀ in coitus, C. A. Frost). R. I.: Kingston, VI.12.19 (URI), VI.18.42 (HK), VI.23.06 (URI); Providence, VII.2 (URI). CONN.: New Haven and Stamford, VI.11 (F). Resume: all states, extreme dates VI.4–IX.14. It was observed to be numerous in morning, gradually reduced in numbers during afternoon, and then briefly active again at sunset.

C. frigida xantha Philip. N. H.: Milford and Franconia, VII.8 (B).

C. fuliginosa Wiedemann. ME.: Eastport, VII.15.52 (HK); Southwest Harbor, VII.9.10 (UM). N. H.: Durham, Hampton, Lee, VI.6–VII.2 (B). MASS.: East Sandwich, VII.2 (UM); Scituate, VI.53 (EIC); Yarmouth, VI.21 (UM). R. I.: Jamestown, VI.6.51 (HK). CONN.: New Haven, Rowayton and Stratford, VI.6–VII.9 (F). Resume: all states but Vermont; extreme dates VI.6–VII.15.

This species develops in salt marshes and is probably more common than the number of collections indicate. Johnson (1925) gives additional records without specific localities.

C. geminata Wiedemann. ME.*: Portland, VII.14.52 (HK); Richville, VII.12. 52 (abundant with *univittata* and *montana,* HK). N. H.: eleven localities, VII.5–VII.25 (B). VT.: Moscow, VII.15. 52 (EIC); Warren Mt., VII.17.52 (EIC, male feeding upon *Spiraea*); Winooski, VII.20 (URI). MASS.: Amherst, VI.30, VII.6, VII.17 (EIC and UM); Cushman, VII.8.51 (EIC); Leverett, VII.13.52 (EIC); South Amherst, VII.2.51 (EIC); Stockbridge, VII.18.51 (EIC). R. I.: Coventry, VII.14.52 (FRL); VII.19.52 (HK); Kingston, VII.10.50, VII.28.50, VIII.2.05 (URI); Washington County, VI.29.37 (URI); Wickford, VII.18.52 (FRL). CONN.: five localities, VI.19–VII.26 (F). Resume: all states; extreme dates VI.19–VIII.20. In Massachusetts this is the most abundant species in some localities, attacking very actively.

C. geminata impunctata Kröber. N. H.: Durham, VII.18 (B).

C. hinei Daecke. MASS.: West Peabody, Wellesley, Dover, Wellfleet, New Bedford, VII.8–VIII.30 (J). R. I.: (P).

C. inda Osten Sacken. N. H.: Milford and Pittsburg, VI.20–VII.1 (B). VT.: Downer State Forest, VI.10.52, VI.30.52, VII.8.52, VII.14.52 (EIC); Groton State Park, VII.1.52 (EIC); Montgomery, VII. 15.52 (EIC); Shoreham, VI.12–13.36 (R. Dow). MASS.: Amherst, VI.14.40 (at light, M. E. Smith); Chicopee, VII.4 (UM); Longmeadow, VI.18 (UM); Melrose, VII.4 (UM); Mt. Toby, VI.16.34 (UM). R. I.*: Kingston, VII.13.51 (HK). CONN.: Suffield, VI.13.37 (Dow and Blake); four localities, VI.12–VI.26 (Br, F). Resume: all states but Maine; extreme dates VI.1–VII.15.

This species is never very abundant at one place but is common at least in Vermont.

C. lateralis Wiedemann. ME.: Bethel, VII.7 (Banks); Byron, VII.13.52 (HK); Eastport, VII.15.52 (HK); Kingfield, VII. 13.52 (very abundant with *vittata,* HK); Lakewood, VII.13.52 (HK); Parkeman, VII.13.52 (HK); Millinocket, VII.14.52 (HK); Mt. Desert, VII.25, VII.28 (CPA); North New Portland, VII.13.52 (abundant in hemlock, arbor-vitae, tamarack bog, HK); Pillston, VII.11 (Banks); Rangeley, VII.13.52 (HK); Richville, VII.12.52 (HK); Salem, VII.13.52 (HK); South West Harbor, VII.26.10 (Banks); Springfield, VII.14.52 (HK); Stockton Springs, VII.15.52 (HK); Whitefield, VII.11 (Banks); Yasselboro, VII.15.52 (JCK); York Beach, VII.11.52 (HK). N. H.: Dixville Notch, VII.10.52 (biting), VII. 23.52 (EIC, biting in open areas, not in woods); Third Connecticut Lake, VII.9.

52, VII.22.52 (EIC); twenty-two localities, VI.11–VIII.24 (B). VT.: Avery's Gore, VII.15.52 (in open area, EIC); Coventry, VII.23.52 (abundant, EIC); Downer State Park, VII.14.52 (EIC); Groton State Park, VII.1.52 (abundant), VII.16.52 (abundant), VII.23.52, VII.31.52 (EIC); Jacksonville, VI.24.34 (H. D. Pratt); Missisquoi Refuge, VII.15.52 (EIC); Montgomery Center, VII.15.52 (EIC); Moscow, VII.15.52, VII.24.52 (EIC); Mount Holly, VII.18.52 (EIC); Newport, VII.10.52 (EIC); Warren Mt., VII.17.52, VII.25.52 (male feeding on *Spiraea,* EIC). MASS.: Amherst, VII.22.23 (UM); Montague, VII.23.51 (EIC); Prescott; Rowe, VII.11.51, VII.26.51 (EIC); Templeton, VII.9.51 (EIC); Winchendon, VII.7.51 (EIC). CONN.: three localities, VII.13–VII.20 (F). Resume: all states but Rhode Island; extreme dates VI.11–VIII.24, with great majority in VII.

Blickle (1954) lists this as one of the four most important species in New Hampshire. It was the most commonly collected species in Maine and Vermont. It is less common in southern New England.

C. lugens Wiedemann. CONN.: (Brennan, 1935).

C. mitis Osten Sacken. ME.: Katahdin, VII.14.52 (MFS); Mt. Desert, VI.19.29 (UM). N. H.: Lower Pantook, VI.25.52 (EIC and FRL); Third Connecticut Lake, VI.24.52 (EIC and FRL); six localities, VI.11–VII.7 (B). VT.: Bradford, VI.5.53 (HK); Downer St. Forest, VI.16.52 (EIC); Groton St. Park, VI.5.52 (very bothersone, EIC). MASS.: Belchertown, VI.12.39 (UM). R. I.: Kingston, VI.15.52 (HK). CONN.: Canaan, VI.14–VI.29 (F). Resume: all states; extreme dates VI.5–VII.14, with majority of collections in VI.

This species attacked very severely, often with *carbonaria.*

Blickle (1954) reports this as an abundant and economic species in New Hampshire in early summer.

C. moecha Osten Sacken. ME.: North New Portland, VII.13.52 (HK); Waterville (J). N. H.: one locality (J); five localities (B), VI.1–VIII.25. VT.*: Bennington, July, 1950 (HK). MASS.: Sharon (J); Winchendon, VII.9.51 (EIC). R. I.: Kingston, VII.13.51 (HK); Providence, VII.13 (URI). CONN.: Hop River, VII.2.52 (HK); four localities, VI. 21–VIII.8 (F). Resume: all states; extreme dates VI.1–VIII.25.

This species appears to attack without the usual buzzing and warning typical of the genus *Chrysops.*

C. montana Osten Sacken. ME.*: Bethel, VII.12.52 (HK); Richville, VII. 12.52 (HK). N. H.: three localities, VII.6–VII.18 (B). VT.: Bennington, July, 1950 (HK). MASS.: Montague, VII.23.51 (EIC); Newton, VII.2.50, VII. 14.51, VII.23.50 (A. Feldman); Northboro, VI.24.37 (C. A. Frost). R. I.: Kingston, VII.4.52 (HK). CONN.: four localities, VII.4–VII.6 (F). Resume: all states; extreme dates VI.4–VIII.20 (J).

Stone (1930) found it to be practically confined to the vicinity of lakes and ponds. Abundant in Hammond's Wood near Hammond's Pond, Newton, Massachusetts on VII.14.

C. nigra Macquart. ME.: Madrid, VII. 13.52 (HK); Mt. Desert, VI.16.35, VI. 21.35 (CPA); Upper Ebeemee Lake, VII.14.52 (HK). N. H.: Dixville Notch, VII.23.52 (EIC); Lower Pantook, VI.25. 52 (EIC, FRL); Third Connecticut Lake, VI. 24.52 (EIC). VT.: Downer St. Forest, VI.14.52, VI.16.52, VI.23.52 (biting, EIC); Groton St. Park, VI.16.52, VII.1.52 (EIC); Guildhall, VI.26.52 (EIC). MASS.: Amherst, VI.35, VI.6.19 (FRS); Cushman, VII.8.51 (EIC); Lee, VI.7.34 (FRS); Springfield, VI.18.99 (UM); Waltham, 1952; West Falmouth, VI.12 (UM); Winchendon, VI.22.51 (EIC). R. I.: Exeter, VI.18.52 (HK); Greene, VII.1.52 (HK); Kingston, VI.17.05 (URI); Providence (Roger Williams Park), VI, VI.2 (Davis); Washington Co., VII.4.42 (URI). CONN.: Lyme and North Haven, VI.16–VII.1 (F) and Stamford (Br). Resume: all states; extreme dates V.30–VIII.2 (J). A formidable pest appearing with *carbonaria* and *mitis* in large numbers.

C. nigribimbo Whitney. N. H.: Milford, VII.9–VII.21 (B). MASS.: Martha's Vineyard, VI.27.30 (CWJ); Fall River, Hyannisport, Springfield, Wellesley, V.24–VII.19 (J).

C. nigripes Zetterstedt. ME.: (P).

C. obsoleta Wiedemann. MASS.: Chicopee, VII.26.96 (UM). R. I.*: Providence, IX.2 (URI). CONN.: four localities, VI.19, VIII.23 (F, J).

C. pudica Osten Sacken. N. H.: Durham and Lee, VII.4 (B). MASS.: Eastham (UM); Northboro, VI.24.37 (C. A. Frost). R. I.: Kingston, VI.26.42, VII.49, VII.2.53, VII.7.50, VII.19.48 (HK), VIII.5.50 (JCK), VIII.9.50 (URI); Narragansett, VIII.9.50 (URI). CONN.: New Haven, VII.4 (?) (F); Stamford (F). Resume: all states but Maine and Vermont; extreme dates VI.24–VIII.9.

Johnson (1925) reports the species, in particular, along the coast of Massachusetts south of Boston.

Stone (1930) took larvae in wet mud, usually in unshaded places and in boggy meadows fed by springs, and one in a creek bank and one at the margin of a swamp. Philip (1931) classified the habitat as marshes with an indefinite shoreline, and running water.

C. sackeni Hine. N. H.: five localities, VI.17–VIII.8 (B). VT.: Sand Bar State Park, VII.30.52 (EIC, Shannon Fly Trap). MASS.: Woburn, VII.11.07 (UM). R. I.: Kingston, VII.17.50 (HK). CONN.: Putnam, VI.15.33 (CPA).

C. sequax Williston. MASS.: (Brennan, 1935).

C. shermani Hine. ME.*: Byron, VII.13.52 (very common, HK); Old Spec Mt., VII.18.51 (JCK). N. H.: Berlin, Dixville, VI.19.20 (URI); Dixville Notch, VII.23.52 (EIC). VT.*: Avery's Gore, VII.15.52 (EIC); Downer State Forest, VII.21.52, VIII.1.52, VIII.8.52 (EIC); Groton State Park, VII.1.52, VII.16.52, VII.31.52, VIII.14.52 (EIC, Shannon Fly Trap); Maidstone State Forest, VII.23.52, (abundant, EIC). Resume: Maine, New Hampshire, and Vermont; extreme dates VI.19–VIII.14.

This species, generally considered rare, was locally abundant. It is a persistent attacker.

C. sordida Osten Sacken. ME.: Madrid, VII.13.52 (HK); Mt. Katahdin, VII.13.23 (J). N. H.: Zealand Camp, Twin Mt., VI.26.52 (FRL); seven localities, VI.19–VII.16 (B); two localities, VII.4.28 (J); Third Connecticut Lake, VI.24.52 (EIC, FRL). VT.*: Lake Willoughby, VI.17–29.45, 1800 ft. (CPA). Resume: Maine, New Hampshire and Vermont; extreme dates VI.17–VII.16.

Blickle (1954) lists it as an abundant and economic species in New Hampshire in early summer.

C. striata Osten Sacken. ME.: Burnham, VIII.13.51 (HK); Orono (URI). N. H.: Berlin (URI); eight localities, VI.22–VII.30 (B). VT.*: Sand Bar State Park, VII.30.52, VIII.7.52 (EIC, Shannon Fly Trap). MASS.: Holyoke, VII.31.98 (UM); Montgomery, VII.2.98 (UM). R. I.: Kingston, VII.17.50 (HK). CONN.: four localities, VI.21–VII.18 (F). Resume: all states; extreme dates VI.21–VIII.13.

Blickle (1954) lists this as one of the four most important species in New Hampshire. Although rather abundant in Vermont on July 30, it was rare in the same area by August 7.

C. univittata Macquart. ME.: Bethel, VII.12.52 (HK); Richville, VII.12.52 (HK); N. H.: ten localities, V.21–IX.11 (B). MASS.: Amherst, VII.20.52, VIII.6.51 (EIC); Coltsville, VII.18.51 (EIC); Danvers, VII.29.50 (A. Feldman); Leverett (EIC); Montague, VII.23.51 (EIC); Montgomery, VII.7.98 (UM); Mt. Toby, VI.18.51 (EIC); Springfield (UM); South Amherst, VII.2.51, VII.23.51 (EIC); West Springfield, VI.27.96 (UM); Winchendon, VIII.1.51 (EIC). R. I.: Cumberland, VII.3.10 (URI); Exeter, VII.13.39 (URI); Greene, VII.13.14 (URI); Kingston, VI.29.51, VII.8.52, VI.12.50, VII.17.50, VII.21.47 (HK). CONN.: Stonington, VII.8.52 (HK); Winthrop, VI.20.52 (HK); many localities, VI.16–VIII.3 (F). Resume: all states except Vermont; extreme dates V.21–IX.11.

Blickle (1954) lists it as one of the four most important species in New Hamp-

shire. This species, *C. vittata* and *C. geminata*, are the most important species in southern New England. It has not been reported from Vermont, despite rather intensive collecting.

C. vittata Wiedemann. ME.: Kingfield, VII.13.52 (HK); Mt. Desert, VII.25.38, VII.27.38 (CPA); Richville, VII.12.52 (HK); Springfield, VII.14.52 (attacking severely, with *C. lateralis*, HK). N. H.: twelve localities, VI.19–IX.9 (B). VT.*: Downer State Forest, VIII.1.52 (EIC); Groton State Park, VII.31.52 (EIC); Jacksonville, VI.28.37 (H. D. Pratt); Moscow, VII.24.52 (EIC); Shoreham, VI.13.36 (R. Dow); Winooski, VIII.01 (URI). MASS.: Amherst, Chicopee, Chilmark, Coltsville, Cushman, Montgomery, Mt. Tom, Northampton, Orient Springs, Pittsfield, Salem, South Amherst, Stockbridge, Wenham, Westhampton, West Tisbury, Williamstown, Winchendon, VI.6–VIII.28 (EIC, UM, R. Dow, A. P. Morse). R. I.: Coventry, VIII.5.51 (A. Thomas); Kingston, VII.25.50 (JCK), VII.28.50 (Campbell), VIII.1.52, VIII.2.50 (HK), VIII.2.06 (URI), VIII.5.46 (HK), Peace Dale, VIII.1.51 (D. J. Zinn). CONN.: many localities, VI.19–VIII.8 (F). Resume: all states; extreme dates VI.6–IX.9.

Stone (1930) found larvae in wet mud at margins of ponds and streams, usually shaded. It has also been taken in temporary ponds.

It is the most troublesome *Chrysops* in New England, especially in the southern part. Blickle (1954) lists it as one of the four most important species in New Hampshire.

C. wiedemanni Kröber. ME.: Bradford, VII.16.52 (HK); Millinocket, VII.14.52 (HK); Princeton, VII.14.52 (HK); Upper Ebeemee Lake, VII.14.52 (HK). N. H.: eight localities, VI.12–IX.9 (B). VT.*: Downer State Forest, VIII.1.52, VIII.15.52 (EIC); Groton State Park, VIII.14.52, VII.31.52 (EIC); Newport, VIII.19.52 (EIC); Winooski, VIII.20.01, VIII.21.01 (Davis, URI). MASS.: Montague, VII.23.51 (EIC); Mt. Tom, VII.16.98 (UM); Natick, VII.29.28 (BU); South Amherst, VII.14.29, VII.23.51 (EIC), VIII.6.51 (EIC); Wenham, VIII.22.27 (A. P. Morse). R. I.: Exeter, VIII.6.39 (URI); Kingston, VIII.49 (HK). CONN.: many localities, VI.19–VIII.15. Resume: all states; extreme dates VI.12–IX.9.

Adults are very silent when they approach, and they seem to like to bite along the arms as well as the head.

Stone (1930) found larvae in the muddy banks of streams and the margins of small ponds, but always in very wet places. Four pupae were found in a boggy meadow.

Summary. Thirty-seven species and two subspecies are listed for New England. *Vittata* is the most abundant and economic species throughout New England. *Univittata* is abundant except in Vermont, and *celer, geminata* and *wiedemanni* are common throughout New England. *Callidula* is abundant in southern New England, while *carbonaria, excitans, lateralis, sordida* and *striata* are of major importance in northern New England. *Shermani*, ordinarily considered rare, was found to be locally abundant in Vermont. Recorded for the first time are ten species for Vermont, three for Rhode Island, and four for Maine. Geographical and seasonal collecting data are given for each species.

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HIGH ALTITUDE OBSERVATION CHAMBER FOR INSECT PHYSIOLOGY STUDIES [1]

J. D. DECOURSEY,[2] A. P. WEBSTER [3] and E. R. BABCOCK [4]

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A high altitude observation chamber for the observance of gross insect behavior patterns and physiologic changes that may occur at varying altitudes was described by Perry and Webster (1950). The chamber of this equipment was evacuated by means of a Luer syringe. Hiestand and Stemler (1951) studied the acquired tolerance of various insects to repeated decompressions by using test tubes cut to appropriate lengths and explosively decompressed by means of a vacuum pump.

The apparatus developed by Perry and Webster has since been enlarged and modified to provide five observation chambers for the study of a number of insects at two different simulated altitudes simultaneously. It is equipped with a cooling system to maintain lower temperatures (see Figure 1).

The equipment currently in use consists of a plastic box housing five removable, stoppered chambers of pyrex glass. The bases of these chambers fit into center drilled, inverted Number 6 rubber corks. The openings at the bases of three of these corks are slipped over the ends of one-fourth inch copper tubing leading to a common copper duct which passes through a calibrated vacuum gauge to the vacuum source. The remaining two chambers are similarly connected through another gauge. All joints were made vacuum tight with Glyptal.* The vacuum is furnished either by two 100 cc. Luer syringes supported by clamps to the frame, or by an electric vacuum pump. When the syringe is utilized, the registered vacuum is maintained by closing the cut-off valve located below the gauge. When the vacuum pump is used, the leads are removed from the two syringes, brought together through the use of rubber tubing and a glass "Y" to a common rubber duct leading to the pump. The vacuum in each system is maintained by adjusting the air-bleeder valve located below the cut-off valve. Fine adjustment may be made by adjustable metal clamps on the rubber hoses leading from the pump through the valves to the two gauges. By this system, vacuum levels can be maintained from one to thirty inches of mercury.

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This work is not to be construed as necessarily reflecting the views of the Department of the Navy.

* General Electric Company.

The cooling system is a one-eighth horsepower refrigeration unit with evaporator coils within the upper periphery of the plastic box encircling the group of test chambers. It was found that even with heavy insulation, controlled temperatures could not be maintained below —5° Centigrade.

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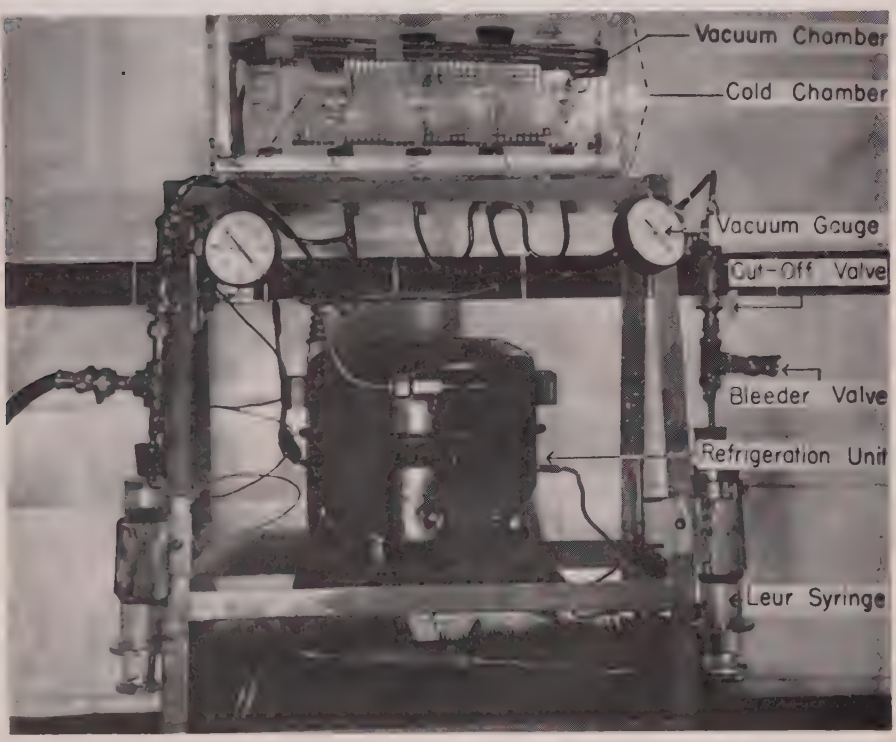

ACTIVITIES OF PUBLIC HEALTH INSECT CONTROL STUDY AND REPORT GROUP ON THE NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE

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One method of developing the country's water and land resources is on the basis of comprehensive river basin development programs. Several Federal agencies are uniting with the states concerned for the purpose of coordinating the various basin programs. In the northeastern states, this has been done through the work of the New England-New York Inter-Agency Committee. All the river basins in the six New England States and several basins in New York are under study. Long Island and three basins (the Susquehanna, Delaware, and Allegheny) in upstate New York are not included in this program. The Federal participants in this project are: the U. S. Army Corps of Engineers as Chairman Agency; the Departments of Interior, Agriculture, Commerce, and Health, Education and Welfare; the Federal Power Commission, and the State Department. Eleven study and report groups have been formed to gather data and prepare comprehensive basin reports. The Coordinator of each group is a representative from one of the above Federal agencies responsible for his agency's field of interest, for example, the recreation and fish and wildlife groups are headed by personnel from the Department of the Interior; the water pollution and water supply groups and the Public Health Insect Control Study and Report Group are headed by personnel from the Department of Health, Education, and Welfare.

A portion of the work and responsibilities of the Public Health Insect Control Study and Report Group is to determine the effects of water resources development upon biting insect incidence. It is a well known fact that severe public health insect problems may develop as a result of water and/or land resources development work. Studies of these problems have shown that in a large measure they could have been minimized or eliminated had they been given specific consideration during the planning and construction phases of the project. The group responsible for the study of insects of public health importance, as vectors and/or as a nuisance factor, in the New England-New York Inter-Agency Committee is the Public Health Insect Control Study and Report Group. The Coordinator of the group is an officer of the Public Health Service. Other members of the group consist of representatives from the Departments of the Army, Interior, and Agriculture, and one member from each of the seven states within the New England-New York area. The objectives of the Public Health Insect Control Study and Report Group are to determine:

1. Extent of mosquito-borne diseases which have occurred or are occurring.
2. Density and prevalence of both disease transmitting and otherwise objectionable mosquitoes, blackflies, tabanids, heleids, and other biting insects, particularly those which are produced in aquatic situations.
3. Characteristics of various aquatic environments which produce disease carrying mosquitoes and other biting insects of public health significance, and the extent to which these insects will be increased or diminished as a result of the development of water and related land reservoirs.
4. Probable effect of water developments on potentialities for transmission of vector borne diseases in man.

5. Specific problems related to extent, location, and type of developmental projects and programs to be made, e.g., as they may affect concentrations of human population, recreational areas, and others.
6. Estimates as to severity of the general biting insect problem, estimated insect control costs, and monetary benefits to be derived from control work on a basin-wide basis.

Although the Public Health Service and more specifically the Communicable Disease Center had no work of this type in the New England-New York area underway until the creation of the Inter-Agency Committee, considerable basic information was available in the files of State and local health departments, agriculture departments, universities, colleges, experiment stations, and other agencies. The information was assembled by the Public Health Insect Control Study and Report Group and analyzed to determine the incidence and significance of vectors of insect-borne diseases such as malaria, eastern equine encephalitis, Rocky Mountain spotted fever, and tularemia, and the incidence of annoyance by mosquitoes and other biting flies such as blackflies, deer flies, greenhead flies, punkies, and ticks.

To supplement the data abstracted from the published and unpublished literature, field investigations were conducted to determine the distribution and prevalence of important pests and vectors of diseases. These investigations included reconnaissance of areas where basin development projects are planned and particularly of areas where no field records or reports were available.

Because of the relatively short insect season, abstracting of data and assembling and identifying specimens were confined to fall and winter months. During the spring, with the first snow melt, and in the summer all-out efforts were made to secure field data. Two temporary field entomologists were employed by the Public Health Service to gather data in New York, Vermont, northern New Hampshire, and western Massachusetts. In addition, two full-time entomologists, also from the Service, were assigned to gather field data in Maine and in selected areas of Massachusetts, Connecticut, and Rhode Island. In addition, the latter two men carried on the laboratory and indoor work listed above during the fall and winter months. Time being a limiting factor, field activities were conducted during the first two years of the project only, that is, 1951 and 1952. It might be pointed out at this time that originally the work of the Inter-Agency Committee was scheduled to be completed by June 30, 1954, and a full combined report of its findings, conclusions, and recommendations was to be submitted to the President on that date. Because of the magnitude of the undertaking, however, this date has now been extended to June 30, 1955. At the end of the 1952 summer season, sufficient data had been compiled to prepare the first basin report of the Public Health Insect Control Study and Report Group. The reports of this group are prepared in two parts. Part I contains the introduction, summary, conclusions, and recommendations in brief form. Part II cites the present status of public health insects and their control, benefits and costs of insect control, and the effects of water resources development in greater detail.

A brief glance at the study area may make one wonder how such a limited number of personnel were able to do an adequate job of surveying the insects of New England and New York. Simply, it had to be kept in mind that the work did not include an intensive ecological study of all the species of insects within this area; rather it was intended to determine what the general effects of land or water resources development would have upon the population of the important species and on the breeding areas, and what to recommend as regards control of existing nuisance conditions. The starting point of the study was in the winter of 1951 with a scanty review of the literature to learn how much had already been done by other groups. The literature revealed that very little or no records were avail-

able for Maine and Vermont, but that many studies had been conducted by State universities and other State agencies in New York, Massachusetts, New Hampshire, Connecticut, and Rhode Island. Consequently, in the summer of 1951, activities were devoted to filling the gaps in the information from New York, Massachusetts, Connecticut, and Rhode Island and to initiating studies in Maine. In the summer of 1952, Vermont and Maine were studied, and selected areas in the other States were reviewed. Sampling techniques and equipment were those commonly employed by field entomologists. New Jersey light traps, Shannon traps, biting records, and larval collections were made regularly. With a more thorough review of the published and unpublished literature, the picture began to fill in and round itself out to the extent necessary for a basin-wide study such as that undertaken.

The introduction states the scope of the report, cites acknowledgments, and defines "public health insects." The definition of "insects of public health importance," for the purpose of this program, includes not only insect species known definitely to be potential disease vectors, such as malaria and encephalitis transmitters, but also those insects which are of importance because of their annoyance. These include pest mosquitoes, blackflies, punkies, deer flies, horseflies, and ticks. This inclusion is justified because physical efficiency and comfort, on which mental equanimity depends to a substantial degree, often may be seriously disturbed by the continuous annoyance of pestiferous insects. This principle already has been recognized by the U. S. Public Health Service. In addition, the Armed Forces have developed programs and practiced insect control for the protection and well-being of military personnel. The summary of the report is a brief account of the incidence of disease found within the basin and the incidence and prevalence of pest or noxious insects. A statement of estimated cost for insect control and an estimate of the magnitude of the insect problem are given in the report, but the interpretation of the feasibility of a program is left to the discretion of the individual communities. It is pointed out that when deciding upon the feasibility of control measures, consideration must be given to the intensity of the problem, as well as to the type and extent of control work involved. The intensity of the pest problem is not determined solely by the number of pest insects present. It must also be determined by the number of people affected in a given area. An estimate is given, however, on average yearly costs over a period of years in centers of population and resort areas for the basin as a whole. The monetary benefits which would be derived from pest insect control are difficult to evaluate in dollars and cents because these benefits are largely intangible. However, in this report, it is estimated that an increase in recreational income, varying from 2 to 25 per cent depending upon the locality in question, can be expected as a result of insect control in resort and camp areas.

When data are available relative to proposed project or program developments at the time of the writing of each report, a summary of effects upon insect breeding areas is given. A point which is emphasized in each report is the need for specific surveys by competent personnel for the determination of necessity and type of each control program.

The basin reports, by virtue of the fact that they are written for the layman, do not have the biologies, seasonal distribution, control methods, or the bibliographies. A report entitled "Supportive Data for Basin and Subregional Reports" is being prepared to give such information and it is anticipated that several papers will be published in scientific journals as a result of these studies.

Of some interest to the reader are two tables included in the reports. The first presents insect densities based upon records compiled during this study and best judgment of those conducting the study, and the second lists the communi-

ties where it is believed consideration of the feasibility of control measures is justified. The latter list is determined by the number of human population affected, insect density, and probable willingness and financial ability of a community to pay for an insect control program. In resort areas the owners are usually very much aware that their livelihood depends upon the tourist trade and are, therefore, generally receptive to promoting insect control. In many non-resort areas, pest insects are still accepted as necessary evils for which nothing can be done.

A little more should be presented about the various reports and the outcome of their distribution. There are three types of reports to be prepared. The first of these is the basin report. This is somewhat comprehensive and detailed for the specific basin. In all, 28 such reports are being written. The second type of report is known as the subregional report. This is made up from a number of basin reports within a given area. For example, Subregion A report is a compilation of all the basin reports of Maine including the Androscoggin River whose headwaters are in New Hampshire. Five such subregional reports will be written. The third type of report is one which is prepared by the Inter-Agency Committee. This report contains the integrated findings, conclusions, and recommendations of all the study and report groups for a given basin. With the writing of this latter report, there will be close coordination between study and report group coordinators. It is at this time that the Public Health Insect Control Group, for example, may suggest to the Fish and Wildlife Service Group that a particular refuge area may be relocated so as not to create a mosquito breeding area near a recreation area or rural community. Conversely, the Fish and Wildlife Service Group may point out the advisability of relocation of a recreational area where some insect control would be necessary because of its greater value as a wildlife area.

The objective of all this work is the preparation of a comprehensive report for the entire area giving recommendations for the best water and land resources development for the overall greater benefit of the entire area and the nation.

More conference information from another letter from Dick Peters dated November 22: "Aside from the names of the participants in the symposia, it is possible to indicate at this writing only that invitational paper acceptances have been received from Fred W. Knipe of Rockefeller Foundation, Donald R. Johnson of Division of International Health, John M. Henderson of Communicable Disease Center, Arthur W. Lindquist, Head, Insects Affecting Man and Animals Section of the U. S. Department of Agriculture, and Cecil R. Twinn, Head, Veterinary and Medical Entomology Unit of Department of Agriculture, Canada. I am still negotiating for someone from Latin America and Dr. Stephen M. K. Hu of Hawaii. This group will be supplemented by progress reports from spokesmen for the various localities throughout the United States engaged in mosquito control."

EDITORIAL SECTION

In the September issue of *Mosquito News,* Miss Sollers, editor of the Bibliography Section, presented some remarks with reference to her department. In the present issue we are offering, below, a contribution from Austin Morrill, editor of the "News and Notes" section. Mr. Morrill has made this section a very lively department, and one of increasing interest to all members of AMCA. It can become of even more interest if more readers will take some action based on Mr. Morrill's remarks...D. L. C.

WHY NEWS AND NOTES?

There are about as many ideas of just what should go into the make-up of our "News and Notes" section as there are members of the Association. If each member who has an idea as to what type of material should be collected would sit down once a year and send in one such item, the editor would "have it made." Some of our members do just that. Some are even so noble that they send in more than one item, or send them in regularly. But most of us do not contribute our share.

Should "News and Notes" contain reviews of publications? Yes, say some members, if such publications are too short or too limited in appeal to merit full reviews but are still of interest. No, say others, "News and Notes" should contain only items about the doings of members. Others say that "News and Notes" should consist of items which can be used by abatement district managers in their publicity releases and educational material. Some readers think "News and Notes" should consist of notes on scientific discoveries and progress which are not yet far enough along to be ready for publication as a technical paper but which may give hints to other workers. What do you say?

Who should send them in? Everybody? Yes, everybody. At the last meeting a motion was passed that Regional Directors should be responsible for sending in notes concerning attainments of members in their regions. Have they done so? Two have. But every member does *something.* How about letting "News and Notes" in on it? Even a post card will do, addressed to the undersigned at Sanitary Engineering Branch, Engineer Research and Development Laboratories, Ft. Belvoir, Va., or to the Editor of *Mosquito News* in Albany, N. Y.

—Austin W. Morrill, Jr.
Associate Editor
("News and Notes")

ASSOCIATION NEWS

HIGHLIGHTS OF THE 1955 MOSQUITO CONTROL CONFERENCE, LOS ANGELES, CALIFORNIA, JANUARY 24–27, 1955

On November 29 the Program Committee for the Joint American-California Mosquito Control Association Conference met in full force to bring into finality the various aspects of the program, local arrangements and ancillary aspects of the Conference.

Mr. Norman R. Ehmann, formerly Entomologist of the Los Angeles City Health Department and now an integral member of the McLean Chemical Company, who has performed an outstanding job as General Chairman of the Conference planning activities, moderated the meeting. Dr. John N. Belkin, Associate Professor of Entomology at the University of California at Los Angeles and Program Chairman of the meetings, reported on the program which is in the closing stages of completion. Invitational papers to be presented the first day of the Conference will cover a broad spectrum of mosquito control developments throughout the United States as well as from Canada, Latin America, India, Hawaii, and elsewhere throughout the world. All four of the symposia scheduled for the second and third days have been effectively developed and the outstanding moderators and speakers appearing on each subject should offer considerable of interest to the audience. Dr. Fred M. Truxal, Curator of the Los Angeles Museum, reported that the call for submitted papers has thus far received only a moderate response. Mr. Gardner C. McFarland of the Los Angeles County Health Department and Manager of the Southeast Mosquito Abatement District, in his capacity as Exhibits Chairman, has been lining up an encouraging number of exhibits, but reports that the help of everyone is needed in order to assure adequate funds by which to make the Conference hospitable to the maximum. Mr. W. Earle Duclus of the Los Angeles City Health Department, Mr. Jack H. Kimball, Manager, and Mr. John G. Shanafelt, Entomologist, of the Orange County Mosquito Abatement District, and Mr. Harvey I. Magy, Area Representative of the Los Angeles office of the Bureau of Vector Control, are effectively carrying out their responsibilities in local arrangements to assure smooth functioning of the meetings.

The Committee on ladies' entertainment, headed by Mrs. Ora May Ebeling, wife of University of California at Los Angeles Professor of Entomology, Walter Ebeling, and composed of all the wives of the aforementioned members of the Committee, submits a calendar of events for the ladies which is in the nature of a mandate that the wives accompany their husbands to this Conference. On Monday afternoon, a get-acquainted tea will be held at the Hotel Statler. This will be followed by the Hospitality Hour, Banquet and Dance for all. On Tuesday morning the ladies will tour the U.C.L.A. campus and Art Gallery, arriving at Bullocks Westwood by noon for a luncheon and fashion show. Tuesday afternoon, Mrs. Ebeling will be hostess to the ladies at her home for bridge. On Wednesday, the day will be unscheduled with respect to group activities other than for one function —a trip through the Fox Movie Studio, Hollywood.

In addition to the series of activities for everyone on Monday evening, plans are being made for the entire group to

visit a telecast of some major program being beamed from Hollywood on Wednesday evening, January 26. Also, passes will be available to the ladies, should they wish to attend other major radio and television programs during the few remaining available hours of the day.

As a climax to the Conference, plans are under way to provide transportation for a three-pronged motorcade in order to show off California to our visitors. One motor excursion will depart Thursday afternoon for the Coachella Valley, Palm Springs, Death Valley, and elsewhere mutually desired by this group wishing a looksee at the beautiful features of Southern California. The second prong of the motorcade will head north Thursday afternoon through the great Central Valley, stopping from time to time to visit various mosquito abatement districts and detouring to the extent possible into the high Sierras to see the big trees, the snow, and the panoramic scenery. Destination will be the San Francisco-Bay Area. The third option will be a trip northward to the Bay Area via the Coastline, stopping as desired at such points of interest as Santa Barbara, the Hearst Castle at San Simeon, Point Sur, Carmel-By-the-Sea, etc.

These motorcades will be able to be arranged for at the Conference. The important thing is for everyone to allow an additional several days on their trip itinerary in order to make it possible. Those who come to the Conference by air, rail or bus and who intend to go on the motorcades heading northwards, should make reservations for departure from either Oakland or San Francisco at their time of convenience after Sunday, January 30. It is hoped that those who travel north to the Bay region will also take time to visit the University of California at Berkeley, the various mosquito abatement districts in the Bay area, and the Bureau of Vector Control of the State Health Department. Time should also be allowed to see San Francisco by day and by night.

So, how does all this sound? If you haven't already done so, be sure to make your reservation beginning the night of Sunday, January 23, at the Hotel Statler in Los Angeles. Identify your name and that of your party with the AMCA-CMCA Conference. A wonderful time is guaranteed!

Everyone on the "Mosquito News" mailing list is slated to receive a personal invitation from Mr. C. Donald Grant, President of the California Mosquito Control Association, to attend this Joint Conference. A copy of the full printed program is also scheduled for mailing to everyone by early in January.*—R. F. Peters.

* The Los Angeles Chamber of Commerce has already seen to it that the members have received copies of the tentative program of the Joint Conference. Note that registration is at 9:00 A.M. Monday the 24th of January at the Statler.

NEWS AND NOTES

The Seminar on Fogs and Mists, held on 29 and 30 September and 1 October, in Toledo, was a thoroughgoing success. Twenty-three papers were presented before a gathering of 107 persons, a gathering which included 10 new members. Exhibits were displayed by 12 firms and a demonstration of fogging and mist blowing machines was made by the Silver Creek Precision Corp., (Microsol), Todd Shipyards Corp. (TIFA), Buffalo Turbine Agricultural Equipment Co., John Bean Division of the Food Machinery and Chemical Corp. (Rotomist), Curtis Automotive Co. (Dynafog), Hardie Mfg. Co. (Acromist), and Oliver Corp. (Iron Age), Concession Supply Co. (New Jersey Light Traps), the Bell Telephone Co., (Car telephone systems), and the Willys Motors Co., (Jeeps), displayed and demonstrated their products. The demonstration of equipment was made at the shops and offices of the Toledo Area Sanitary District, where their nearly perfect arrangements for storage and care of equipment and materials, for charting of work areas, briefing, lockers and showers and other essential facilities, were also on display before the admiring and sometimes envious members of the Association.

Under the chairmanship of P. B. Brockway, Jr., the Toledo Area Sanitary District arranged a smooth-running program which could not have been bettered. The program included also the usual banquet, which was made unusual by a speech from Mr. Grove Patterson, editor of the famed *Toledo Blade*. The names of the six members who had come the farthest were also read: Mr. J. Mel Williams, of Sarasota (if you don't know where *that* is, we won't tell you!), Dr. B. I. Gerry of Chatham, Massachusetts, Mr. Oscar Doane, Sr., of Hyannis, Massachusetts, the easternmost point to be represented, Mr. Thomas J. Lynch of Northfield, Illinois, Mr. E. J. Stansfield of Winnipeg, Canada, and Dr. D. J. Peterson of Ottawa, Canada.

Harry H. Stage, who is still energetically assaulting the mosquitoes in Viet Nam, and expects to continue there a good while longer, he says, sends us his latest publication, "Clef pour la determination succinte des Anopheles femelles d'Indochine." Published this year in collaboration with M. Paul Martin of the Institut Pasteur, the bilingual keys look like the sort of thing which field workers anywhere would find highly useful. It is illustrated with diagrammatic pictures of the mosquitoes on which the characters are shown somewhat broadly but unmistakably.

The Eighth Naval District held another of the Navy's excellent Pest Control Conferences on 12, 13 and 14 October at the Naval Air Station of Corpus Christi, Texas. Sponsored by Lt. Gordon W. Warner, MSC, USNR, who is OIC of the Preventive Medicine Unit at NAS, the program also featured talks by George W. Hutton, of BUDOCKS. (These letters will be unscrambled upon request.)

California Vector Views for September (Vol. 1, No. 3) contains a two-page article on "Arthropod-borne Encephalitis in California," which should be of interest to those who spend their days trying to eradicate *Culex*. "The mosquito, *Culex tarsalis*," says the article, "has been implicated as the major vector in California. It is considered the vector of both the Western and St. Louis viruses. The evidence pointing to *C. tarsalis* includes numerous isolations from naturally infected mosquitoes, the feeding habits of the mosquito, the seasonal peak of the mosquito population which corresponds to the peak of human illnesses, and the disappearance of the disease with the disappearance of the mosquito. The mosquito is apparently unaffected by the virus which evidently requires high temperatures for its development."

In this Connection, the Alameda County Mosquito Abatement District reported in September and October that the level of several culicines, including *C. tarsalis*, remained low, despite the fact that the usual trend is upward at this time of year. Harold Gray, Engineer-Manager of the District, adds that early flooding of duck clubs presented a number of problems but that all have been handled reasonably satisfactorily. He writes, "Our general policy of putting the responsibility for mosquito production on the duck club operators is working more effectively each year. . . ."

From the Supervisor of One of the Army's Corps of Engineers Insect and Rodent Control units comes a couple of jingles on mosquito control which he offers as additions to the rhymes published in previous issues. Modelled on and following the famous quatrain on the beetle *Dendroctonus*, they are as follows:

A real cutie cut-up is *Culex*
Who's dying to give you a buzz.
Snobs think her a pest
Or a nuisance at best
But she'll kill you, the things that she does!

Now, this here's the mosquito *Anopheles*
Who deals us a slug of malaria.
She sticks in her bill
And gives us a chill
To teach us we oughta be waria.

In the August Report on Malaria Control Activities in Liberia, George Burton writes

that the rains were drawing to a close and spraying, which had been completed for the second time in Monrovia, was expected to be carried outside the city as soon as the weather permitted. "For the first time since the residual spraying program began in September 1953," he adds, "no anopheline larvae were found in Monrovia proper during the month. . . . Adult anophelines were found only in 3 huts out of the 221 huts checked, or 1.3% positive. These were on sprayed mud walls. Culicines, however, were found in 56 huts, but 9 of these had the adults on bed nets only."

AMONG THE MEMBERS LISTED IN OUR WHO'S WHO IN THE AMERICAN MOSQUITO CONTROL ASSOCIATION, there is one who has been a member since 1945, who is Professor of Zoology and Entomology at his University, who was President of the AMCA in 1951–2, arranged the entertainment at an outstanding meeting held in recent years in his home town. He received his B.S. from the University of Utah in 1926, his M.S. in 1929, and his Ph.D. from Stanford in 1936. He was engineer and supervisor of the Salt Lake City Mosquito Abatement District from 1930 to 1937 and has been a member of the Board of Trustees since that time. He is a member of Sigma Xi and Phi Sigma, and of numerous other scientific associations and societies like our own. He is author of numerous papers on the taxonomy, biology and control of mosquitoes. Who is he? We give you . . . Don M. Rees.

ANOTHER DISTINGUISHED MEMBER FROM OUR ROSTER is Associate Professor in Insect Physiology, especially those phases related to flight and sensory activity. He graduated from the University of London, England, in 1937 with an Associateship in the Royal College of Science. From 1938 to 1946 he was in India teaching and doing general scientific work which culminated in what he modestly describes as "applied entomology" for the armed forces in South East Asia. After receiving his M.S. at the University of Alberta in 1948, this member proceeded to spend a good deal of his time in the Arctic. He is a member of the Institute of Biology, the Royal Photographic Society, the Arctic Institute of North America and the Canadian Entomological Society and has been a fellow of the Royal Entomological Society since 1951. His name? Brian Hocking, of the University of Alberta and the Northern Defence Laboratory at Ft. Churchill, Manitoba.

ARCHIE D. HESS, after two productive years in the Philippines, who parted with him reluctantly, according to information from that country, is now to be addressed at U. S. Public Health Service, P. O. Box 334, Logan, Utah.

"THE VIRGINIA BEACH—PRINCESS ANNE COUNTY MOSQUITO CONTROL COMMISSION," we are informed by the V.M.C.A.'s "Skeeter," "ventured an innovation this year that seems to have been very successful. Instead of preparing their Annual Report in the usual pamphlet form, they took a full page in the weekly Virginia Beach paper, the 'Sun-News,' and with the hearty cooperation of the editor, printed matter, figures, and pictures were skillfully grouped to create a most attractive 'spread.' It was felt that this method of submitting a report would much more nearly reach every interested party and comments seem to verify this belief. If you are interested, ask the Virginia Beach *Sun-News* for a copy of their issue for September 9 and judge the results for yourself."

THE VIRGINIA MOSQUITO CONTROL ASSOCIATION also reports that the town of Bedford had a very bad plague of mosquitoes this summer, despite the dry weather which many folks feel *should* mean no mosquitoes. Seems they were breeding in sewage polluted streams which in wetter seasons are kept flushed. In dry weather, they pocket and breeding is abundant.

THE CITY OF HOLLYWOOD, FLORIDA sends us a press release which indicates alert activity among their mosquito control personnel. "A new part of this city's mosquito control program," they write, "is a 26 foot, flat bottom craft which mounts a fogging machine.

"The craft is especially constructed so that it can move through swampy areas getting the fogging crew and machine into mosquito breeding grounds that were heretofore inaccessible.

"The boat is powered by a 60 horse power inboard engine and cost $1,900. When it is not being used for mosquito control work the boat will be used for rescue work and to patrol the inland waterway to keep boats from speeding."

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HELEN SOLLERS

Plant Pest Control Branch
Agricultural Research Service
United States Department of Agriculture

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THE TOLEDO SEMINAR

The September number of *Mosquito News* carried the program of the Toledo Seminar on "The Use of Fogs and Mists for Adult Mosquito Control." The current number has a brief account of the meetings in the "News and Notes" section on page 221. At the time the September *News* went to press plans had not yet been completed for the publication of the papers, and it was expected that several of them would appear in *Mosquito News*.

Over 100 AMCA members and others attended the meeting, and so much interest was shown that it was decided to publish all of the Proceedings and Papers together, so as not to lose the flavor and character of the meeting, which consisted of a blend of formal papers and informal—and very pointed—discussion. Ordinarily it would not be possible, financially, to publish such complete proceedings, but the Willys Motors Corporation offered to bear the main financial burden of the undertaking and is sponsoring the publication. The title will be "The Use of Fogs and Mists for Mosquito Control."

The title page will carry the information that the pamphlet comprises the papers and proceedings of the AMCA Toledo Seminar, edited by the Toledo Sanitary District, and published through the courtesy of the Willys Motors Corporation. It will be of the same dimensions as *Mosquito News*, and the contents will be substantially as given on pages 171 and 172 of the September *Mosquito News*. Those in attendance at the Seminar and each mosquito control agency having employer membership in the AMCA will receive a copy free of charge. Additional copies may be purchased at a nominal charge—not more than a dollar—to cover the cost of mailing and other expenses.

The Fog and Mist Seminar Proceedings will be available early in 1955. Distribution will be handled by the Toledo Sanitary District, to which inquiries should be sent, in care of P. Bruce Brockway, Jr., Superintendent, 5015 Stickney Ave., Toledo 12, Ohio.